U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-261 018

ASSESSMENT OF INDUSTRIAL HAZARDOUS WASTE PRACTICES, LEATHER TANNING AND FINISHING INDUSTRY

SCS ENGINEERS, RESTON, VIRGINIA

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C.

NOVEMBER 1976

BIBLIOGRAPHIC DATA SHEET

1. Report No.

2.

3. Recipient's Accession No. PB-261 018

4. Title and Subtitle
Assessment of Industrial Hazardous Waste Practices--
Leather Tanning and Finishing Industry

5. Report Date November 1976

6.

7. Author(s) E. T. Conrad, Gary L. Mitchell, David H. Bauer

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
SCS Engineers, Inc.
11800 Sunrise Valley Drive
Reston, Virginia 22091

10. Project/Task/Work Unit No.

11. Contract/Grant No. EPA No. 68-01-3261

12. Sponsoring Organization Name and Address
EPA, Hazardous Waste Management Division
Office of Solid Waste Management Programs
401 M. Street, S.W.
Washington, D.C. 20460

13. Type of Report & Period Covered Final
June 1975 to November 1976

14.

15. Supplementary Notes
EPA Project Officer - Allen Pearce

16. Abstracts

This report, which covers the leather tanning and finishing industry, is one of a series of studies which examines land-destined waste from selected industries. For purposes of this study, the tanning industry has been categorized by the types of process solid wastes generated. A total of seven different categories were established.

Process solid wastes from the industry consist primarily of pieces of leather in various stages of processing and wastewater treatment sludges. Virtually every tannery waste stream (except those in vegetable tanneries) was designated as potentially hazardous. The concentration of heavy metals (particularly trivalent chromium, lead, copper, and zinc) were found to be at levels such that the wastes containing these constituents were considered to be potentially hazardous. Literature concerning the hazardous nature of trivalent chromium was conflicting. In 1974, tanneries generated approximately 200,000 metric tons of total process solid wastes of which approximately 75 percent was considered potentially hazardous.

Treatment of tannery wastes is restricted to the dewatering of wastewater treatment sludges. Sludges and other tannery wastes predominantly are being disposed directly to the land. Approximately 60 percent of the potentially hazardous tannery wastes is disposed in some form of landfill with the remainder disposed in trenches or lagoons.

Estimates are given for the cost of potentially hazardous waste treatment and disposal for each category of tannery and for each of the three levels of treatment and disposal.

17. Key Words and Document Analysis. 17a. Descriptors

Leather
Tanning
Hazardous Wastes
Process Wastes
Treatment Technology
Disposal Technology
Landfill

17b. Identifiers/Open-Ended Terms

PRICES SUBJECT TO CHANGE

REPRODUCED BY
NATIONAL TECHNICAL INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

17c. COSATI Field/Group

18. Availability Statement

19. Security Class (This Report) UNCLASSIFIED

20. Security Class (This Page) UNCLASSIFIED

21. No. of Pages

16. Abstracts

This report, which covers the leather tanning and finishing industry, is one of a series of studies which examines land-destined waste from selected industries. For purposes of this study, the tanning industry has been categorized by the types of process solid wastes generated. A total of seven different categories were established.

Process solid wastes from the industry consist primarily of places of leather in various stages of processing and wastewater treatment sludges. Virtually every tannery waste stream (except thos in vegetable tanneries) was designated as potentially hazardous. The concentration of heavy metals (particularly trivalent chromium, lead, copper, and zinc) were found to be at levels such that the wastes containing these constituents were considered to be potentially hazardous. Literature concerning the hazardous nature of trivalent chromium was conflicting. In 1974, tanneries generated approximately 200,000 metric tons of total process solid wastes of which approximately 75 percent was considered potentially hazardous.

Treatment of tannery wastes is restricted to the dewatering of wastewater treatment sludges. Sludges and other tannery wastes predominantly are being disposed directly to the land. Approximately 60 percent of the potentially hazardous tannery wastes is disposed in some form of landfill with the remainder disposed in trenches or lagoons.

Estimates are given for the cost of potentially hazardous waste treatment and disposal for each category of tannery and for each of the three levels of treatment and disposal.

350034

LEATHER TANNING AND FINISHING INDUSTRY

Assessment of Industrial Hazardous Waste Practices

This final report (SW-131c) describes work performed for the
Federal solid waste management program
under contract no. 68-01-3261
and is reproduced as received from the contractor

U.S. ENVIRONMENTAL PROTECTION AGENCY

1976

This report has been reviewed by the U.S. Environmental Protection Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of commercial products constitute endorsement by the U.S. Government.

TABLE OF CONTENTS

Page

1.0 EXECUTIVE SUMMARY 1

1.1 Introduction 1
1.1.1 Coverage 1
1.1.2 Approach 2
1.1.3 Methodology 2

1.2 Industry Characterization 3
1.2.1 Magnitude of the Industry 3
1.2.2 Geographical Distribution 3
1.2.3 Categorization Criteria 5

1.3 Waste Characterization 6
1.3.1 Process Solid Wastes 6
1.3.2 Potentially Hazardous Wastes 12

1.4 Treatment and Disposal Technology 15
1.4.1 Treatment 15
1.4.2 Disposal 16
1.4.3 Alternatives to Disposal 18

1.5 Cost Analysis 20
1.5.1 Treatment 20
1.5.2 Disposal 20
1.5.3 Summary and Discussion 21

2.0 INDUSTRY CHARACTERIZATION 29

2.1 The Tanning Industry 29
2.1.1 Introduction to Tanning 29
2.1.2 Background 33
2.1.3 Industry Organization and Structure 36
2.1.4 Industry Trends and Future Developments 37

2.2 Approaches to Characterizing Tanneries 40
2.2.1 Census of Manufactures 40
2.2.2 Production 40
2.2.3 Tanning Process 41
2.2.4 Raw Material 41
2.2.5 Industry Categorization 45

Page

3.0 WASTE CHARACTERIZATION 49

3.1 Development of Typical Plants 49
  3.1.1 Approach to Waste Characterization 49

3.2 Determination of Potentially Hazardous Waste 52
  3.2.1 Criteria 52
  3.2.2 Definition of Potentially Hazardous Waste 54
  3.2.3 Discussions of Hazardous Constituents 56

3.3 Complete Chrome Tannery 61
  3.3.1 Plant Operations 61
  3.3.2 Potentially Hazardous Solid Waste 64
  3.3.3 Non-Hazardous Solid Waste 68
  3.3.4 Factors Affecting Future Solid Waste Generation 68
  3.3.5 Typical Plant Summary 69
  3.3.6 EPA Region and National Waste Summary 69

3.4 Vegetable Tannery 80
  3.4.1 Plant Operations 80
  3.4.2 Process Solid Waste 80
  3.4.3 Factors Affecting Future Solid Waste Generation 83
  3.4.4 Typical Plant Waste Summary 83
  3.4.5 EPA Region and National Waste Summary 84

3.5 Sheepskin Tannery 84
  3.5.1 Plant Operations 84
  3.5.2 Potentially Hazardous Solid Waste 86
  3.5.3 Non-Hazardous Solid Waste 88
  3.5.4 Factors Affecting Future Solid Waste Generation 88
  3.5.5 Typical Plant Waste Summary 89
  3.5.6 EPA Region and National Waste Summary 89

Page

3.6 Split Tannery 94
  3.6.1 Plant Operations 94
  3.6.2 Potentially Hazardous Solid Waste 94
  3.6.3 Non-Hazardous Solid Waste 97
  3.6.4 Factors Affecting Future Solid Waste Generation 97
  3.6.5 Typical Plant Waste Summary 98
  3.6.6 EPA Region and National Waste Summary 98

3.7 Leather Finishers 98
  3.7.1 Plant Operations 98
  3.7.2 Potentially Hazardous Solid Waste 98
  3.7.3 Non-Hazardous Solid Waste 104
  3.7.4 Factors Affecting Future Solid Waste Generation 104
  3.7.5 Typical Plant Waste Summary 105
  3.7.6 EPA Region and National Waste Summary 105

3.8 Beamhouse/Tanhouse Facilities 110
  3.8.1 Plant Operations 110
  3.8.2 Potentially Hazardous Solid Waste 110
  3.8.3 Non-Hazardous Solid Waste 112
  3.8.4 Factors Affecting Future Solid Waste Generation 112
  3.8.5 Typical Plant Waste Summary 113
  3.8.6 EPA Region and National Waste Summary 113

3.9 Retan/Finishers 117
  3.9.1 Plant Operations 117
  3.9.2 Potentially Hazardous Solid Waste 117
  3.9.3 Non-Hazardous Solid Waste 120
  3.9.4 Factors Affecting Future Solid Waste Generation 120
  3.9.5 Typical Plant Waste Summary 121
  3.9.6 EPA Region and National Waste Summary 121

3.10 State and EPA Regional and National Waste Quantities 129

Page

4.0 TREATMENT AND DISPOSAL TECHNOLOGY 135

4.1 Introduction 135
4.1.1 In-Plant Management 135
4.1.2 Collection and Hauling 135
4.1.3 Treatment and Disposal 136

4.2 Present Treatment and Technologies 137
4.2.1 Non-Mechanical Dewatering 137
4.2.2 Mechanical Dewatering 137

4.3 Present Disposal Technologies 138
4.3.1 Open Dumping 138
4.3.2 Landfilling 139
4.3.3 Certified Hazardous Waste Disposal Facilities 141
4.3.4 Disposal in Lagoons, Trenches, Pits, and Ponds 142
4.3.5 Agricultural Spreading 142

4.4 Alternatives to Disposal 143
4.4.1 Municipal Sewage Treatment 143
4.4.2 Source Reduction Through In-Plant Process Change 144
4.4.3 Sale as By-Products 145

4.5 Approach to the Selection of Treatment and Disposal Technologies 147
4.5.1 Technology Levels 147
4.5.2 Treatment 147
4.5.3 Disposal 148
4.5.4 Outline of Subsequent Sections 148

4.6 Treatment and Disposal: Complete Chrome Tanneries 149
4.6.1 Treatment 149
4.6.2 Disposal 151

4.7 Treatment and Disposal: Sheepskin Tanneries 151

4.8 Treatment and Disposal: Split Tanneries 152

4.9 Treatment and Disposal: Leather Finishers 154

Page

4.10 Treatment and Disposal: Beamhouse/ Tanhouse Facility 157
4.10.1 Treatment 157
4.10.2 Disposal 159

4.11 Treatment and Disposal: Retan/ Finishers 159

4.12 Treatment and Disposal Technologies and Waste Quantity Summary 161

5.0 COST ANALYSIS 165

5.1 Bases and Criteria for Cost Estimation 165
5.1.1 Capital Costs 165
5.1.2 Interest Costs 165
5.1.3 Time Index for Costs 167
5.1.4 Useful Service Life 167
5.1.5 Depreciation 167
5.1.6 Operating Expenses 167

5.2 On-Site Waste Treatment 167

5.3 Off-Site Disposal 168

5.4 Treatment and Disposal Costs 168

5.5 Variables Effecting Treatment and Disposal Costs 181
5.5.1 Size 181
5.5.2 Processing Operations 181
5.5.3 Location 181
5.5.4 Method of Dewatering Sludge 182

5.6 Sample Cost Calculation 182
5.6.1 Level I Technology 182
5.6.2 Level II Technology 184
5.6.3 Level III Technology 184

6.0 REFERENCES 187

7.0 ACKNOWLEDGEMENTS 191

Page

8.0 GLOSSARY 193

9.0 APPENDICES 197

A Alphabetical Listing of Establishments in the Leather Tanning and Finishing Industry 199

B Outline of Procedures for Field Visits, Sample Collection, and Sample Analysis 213

C Private Disposal Sites Accepting Tannery Waste 229

D Methodology for Projecting Waste Quantities on a State, EPA Regional, and National Basis 231

LIST OF TABLES

Table		Page
1	Total Process and Potentially Hazardous Solid Waste Generated by All Types of Tanneries in 1974	8
2	Total Process and Potentially Hazardous Solid Waste Generated by All Types of Tanneries in 1977 (Projected)	9
3	Total Process and Potentially Hazardous Solid Waste Generated by All Types of Tanneries in 1983 (Projected)	10
4	Potentially Hazardous Tannery Wastes	14
5	Treatment and Disposal Technology Levels and Associated Potentially Hazardous Waste Quantities	17
6	Summary of Treatment and Disposal Costs for the Typical Tanneries	22
7	Annual Treatment and Disposal Costs	26
8	1974 Tannery Production by State	35
9	Distribution of Tanneries by Size	42
10	Distribution of Tanneries by Tanning Process	43
11	Distribution of Tanneries by Raw Material	44
12	Distribution of Tanneries by Category	48
13	Geometric Mean Compositions, and Geometric Deviations, of Samples of Soils and Other Surficial Materials in the Conterminuous United States	55
14	Potentially Hazardous Tannery Wastes	57
15	Summary of Toxicity-Related Information for Chromium (III), Lead, Zinc, and Copper	58

Table		Page
16	Trivalent Chromium Toxicity to Aquatic Organisms	62
17	Waste Generation Factors for a Complete Chrome Tannery	70
18	Total Process and Potentially Hazardous Waste Generated in 1974 by Complete Chrome Tanneries	71
19	Total Process and Potentially Hazardous Waste Anticipated to be Generated in 1977 by Complete Chrome Tanneries	74
20	Total Process and Potentially Hazardous Waste Anticipated to be Generated in 1983 by Complete Chrome Tanneries	77
21	Total Process and Potentially Hazardous Waste Generated by Vegetable Tanneries	85
22	Waste Generation Factors for a Typical Sheepskin Tannery	90
23	Total Process and Potentially Hazardous Waste Generated in 1974 by Sheepskin Tanneries	91
24	Total Process and Potentially Hazardous Waste Anticipated to be Generated in 1977 by Sheepskin Tanneries	92
25	Total Process and Potentially Hazardous Waste Anticipated to be Generated in 1983 by Sheepskin Tanneries	93
26	Waste Generation Factors for a Typical Split Tannery	99
27	Total Process and Potentially Hazardous Waste Generated in 1974 by Split Tanneries	100
28	Total Process and Potentially Hazardous Waste Anticipated to be Generated in 1977 by Split Tanneries	101

Table		Page
29	Total Process and Potentially Hazardous Waste Anticipated to be Generated in 1983 by Split Tanneries	102
30	Waste Generation Factors for a Typical Leather Finisher	106
31	Total Process and Potentially Hazardous Waste Generated in 1974 by Leather Finishers	107
32	Total Process and Potentially Hazardous Waste Anticipated to be Generated in 1977 by Leather Finishers	108
33	Total Process and Potentially Hazardous Waste Anticipated to be Generated in 1983 by Leather Finishers	109
34	Total Process and Potentially Hazardous Waste Generated in 1974 by Beamhouse/Tanhouse Facilities	114
35	Total Process and Potentially Hazardous Waste Anticipated to be Generated in 1977 by Beamhouse/Tanhouse Facilities	115
36	Total Process and Potentially Hazardous Waste Anticipated to be Generated in 1983 by Beamhouse/Tanhouse Facilities	116
37	Waste Generation Factors for a Typical Retan/Finisher	122
38	Total Process and Potentially Hazardous Waste Generated in 1974 by Retan/Finishers	123
39	Total Process and Potentially Hazardous Waste Anticipated to be Generated in 1977 by Retan/Finishers	125
40	Total Process and Potentially Hazardous Waste Anticipated to be Generated in 1983 by Retan/Finishers	127
41	Total Process and Potentially Hazardous Solid Waste Generated by All Types of Tanneries in 1974	130

Table		Page
42	Total Process and Potentially Hazardous Solid Waste Generated by All Types of Tanneries in 1977 (Projected)	131
43	Total Process and Potentially Hazardous Solid Waste Generated by All Types of Tanneries in 1983 (Projected)	132
44	Treatment and Disposal Technology Levels for Complete Chrome Tannery	150
45	Treatment and Disposal Technology Levels for Sheepskin Tannery	153
46	Treatment and Disposal Technology Levels for Split Tannery	155
47	Treatment and Disposal Technology Levels for Leather Finishers	156
48	Treatment and Disposal Technology Levels for Beamhouse/Tanhouse Facility	158
49	Treatment and Disposal Technology Levels for Retan/Finishers	160
50	Treatment and Disposal Technology Levels and Associated Potentially Hazardous Waste Quantities	162
51	Bases and Criteria for Cost Estimation	166
52	Contractor Hauling and Disposal Costs	169
53	Treatment and Disposal Costs - Typical Complete Chrome Tannery Without Primary and/or Secondary Wastewater Treatment	171
54	Treatment and Disposal Costs - Typical Complete Chrome Tannery With Primary and/or Secondary Wastewater Treatment	172
55	Treatment and Disposal Costs - Typical Sheepskin Tannery	173
56	Treatment and Disposal Costs - Typical Split Tannery	174

Table		Page
57	Treatment and Disposal Costs - Typical Leather Finisher	175
58	Treatment and Disposal Costs - Typical Beamhouse/Tanhouse Facility	176
59	Treatment and Disposal Costs - Typical Retan/Finisher	177
60	Annual Treatment and Disposal Costs	180

LIST OF FIGURES

Figure		Page
1	Distribution of Tanneries	4
2	Potentially Hazardous Solid Waste Generated in 1974	11
3	Typical Tanning Process Steps	30
4	Example of Wastestream Matrix	51
5	Process Flow Diagram - Typical Complete Chrome Tannery	63
6	Process Flow Diagram - Typical Vegetable Tannery	81
7	Process Flow Diagram - Typical Sheepskin Tannery	87
8	Process Flow Diagram - Typical Split Tannery	95
9	Process Flow Diagram - Typical Leather Finisher	103
10	Process Flow Diagram - Typical Beamhouse/Tanhouse	111
11	Process Flow Diagram - Typical Retan/Finisher	118

SECTION 1.0

EXECUTIVE SUMMARY

1.1 Introduction

This industry study is one of a series by the Office of Solid Waste Management Programs, Hazardous Waste Management Division. The studies were conducted for information purposes only and not in response to a Congressional regulatory mandate. As such, the studies serve to provide EPA with: (1) an initial data base concerning current and projected types and quantities of industrial wastes and applicable disposal methods and costs; (2) a data base for technical assistance activities; and (3) as background for guidelines development work pursuant to Sec. 209, Solid Waste Disposal Act, as amended.

The definition of "potentially hazardous waste" in this study was developed based upon contractor investigations and professional judgment. This definition does not necessarily reflect EPA thinking since such a definition, especially in a regulatory context, must be broadly applicable to widely differing types of waste streams. Obviously, the presence of a toxic substance should not be the major determinant of hazardousness if there were mechanisms to represent or illustrate actual effects of wastes in specific environments. Thus, the reader is cautioned that the data presented in this report constitute only the contractor's assessment of the hazardous waste management problem in this industry. EPA reserves its judgments pending a specific legislative mandate.

1.1.1 Coverage. Process solid waste in the leather tanning and finishing industry is the subject of this study. The tanning industry is designated by SIC 3111. Relevant to this study are those establishments within SIC 3111 with production facilities.

Process solid wastes (including liquid sludges) are generated directly as a result of production operations and destined for land disposal. Thus, solid waste associated with in-plant storage or movement of material, e.g., broken pallets, general office waste, and cafeteria waste, was not a part of the project. Similarly, wastewater and air emissions were not included; however, solids resulting from wastewater pretreatment or treatment and residues collected by air pollution control devices were included if disposed to the land.

1.1.2 Approach. Specific tasks of the project were as follows:

- Characterize the industry in terms of number, size, and location of plants.
- Determine the types, quantities, and sources of total process solid wastes and potentially hazardous wastes currently generated by tanneries and project quantities for 1977 and 1983.
- Sample and analyze the solid waste to determine the presence and concentration of potentially hazardous constituents.
- Define potentially hazardous solid wastes applicable to the tanning industry, and characterize the process waste streams as non-hazardous or potentially hazardous using the definition.
- Identify current and potential future methods of treatment and disposal for the potentially hazardous solid wastes and describe three technology levels:
  - Level I--most commonly used current technology.
  - Level II--best current technology in full-scale operation
  - Level III--technology necessary to provide adequate health and environmental protection.
- Estimate the costs of potentially hazardous waste treatment and disposal for the industry.

1.1.3 Methodology. The collection of information necessary to meet the above objectives required field visits to various tanneries and the collection and analysis of solid waste samples. Field visits to disposal sites serving tanneries were also an integral part of the project. Tanneries were selected on the basis that they represented the major types of tanning operations carried on in this country and thus generated solid wastes typical of the industry.

Field visits to tanneries were conducted by staff personnel, sometimes augmented by industry or EPA officials. During the visits, waste management information was collected utilizing standardized data collection forms. Production operations were examined, and solid waste samples were collected at selected tanneries. The samples were shipped to a laboratory for analysis. Land disposal sites were visited whenever possible. A total of 23 sites which receive tannery solid wastes were visited. Often tanneries were selected for visits because they were known to have advanced treatment technology or unique disposal methods. A total of 41 tanneries were visited during the project. They represented 14 percent of the plants in the industry and nearly 50 percent of the industry's production nationwide.

1.2 Industry Characterization

1.2.1 Magnitude of the Industry. The total number of establishments in the leather tanning and finishing industry is 298. According to the U.S. Bureau of the Census, there are 517 establishments in the leather tanning and finishing industry, SIC 3111.[1] However, many of the establishments included in the Census report have no actual leather processing facilities, and therefore were not included as a part of the study.[2] For purposes of this study, the following types of facilities have been eliminated from the Census figures:

- Converters.
- Double entries.
- Hobbyists and taxidermists.
- Other nonproduction establishments.

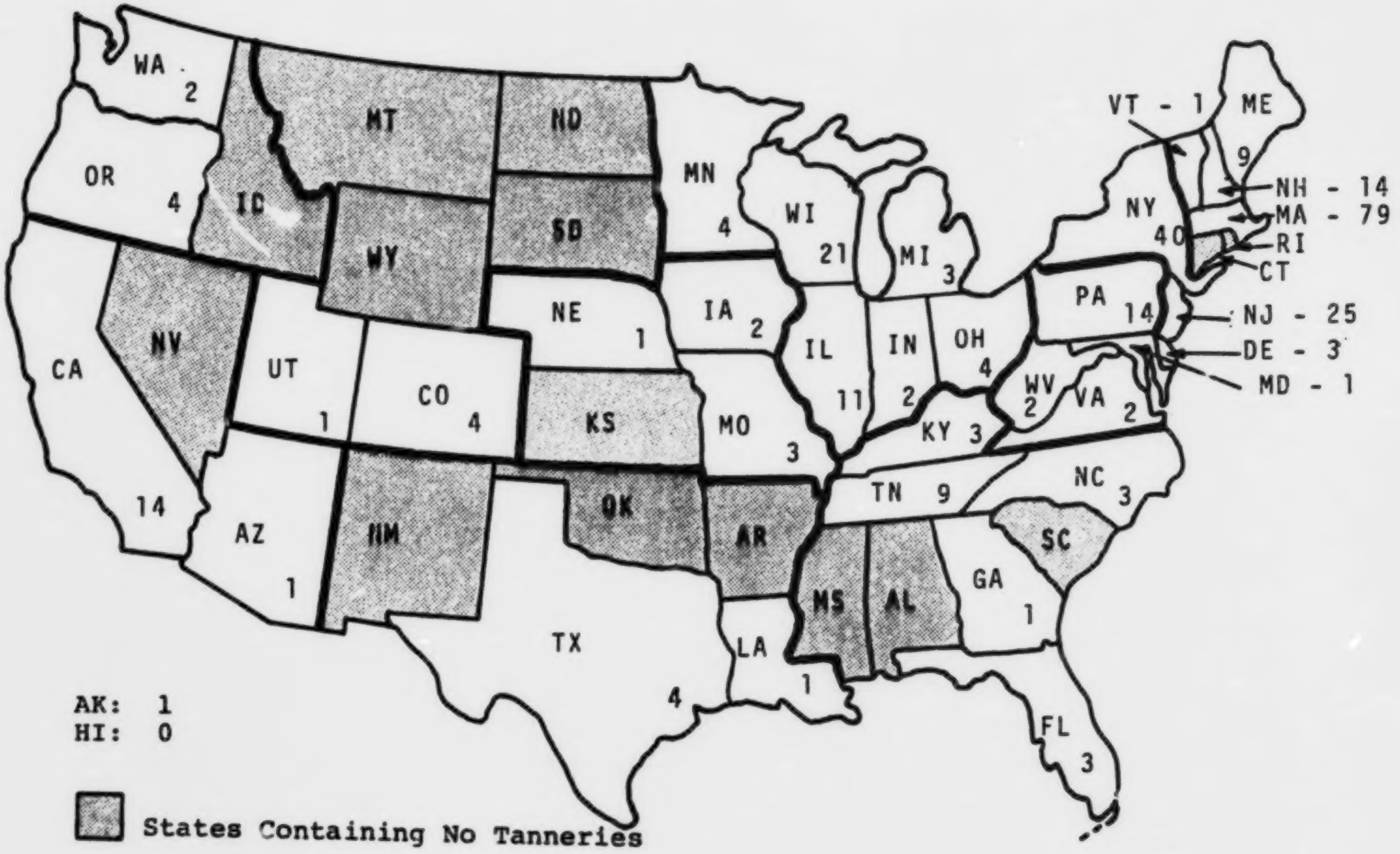
Most of the tanneries in this country are relatively small, family owned businesses. Employment ranges from 5 to 500, and production ranges from less than 200 hides per day to over 2,600 hides per day.[2] The Bureau of the Census reports the value of industry shipments in 1967 as $846 million and in 1972 as $1,026 million.[1] The Tanners' Council of America estimates 1974 value of shipments at $1,026 million.[2]

The sum of the production for all types of tanneries in 1974 is estimated at 35.7 million equivalent hides.[2] This is the total of all hides put into production by all categories of tanneries. Total output production for 1974 was approximately 20 million equivalent hides.[2] The difference is due to the fact that hides may be counted twice. A single hide put into production at a tannery is usually split (sliced through its thickness) after partial processing. This yields two pieces of leather, a grain side and a split. The grain side may be sent to a leather finisher where it is also counted as input. The split is sent to a split tannery where it is counted as input. Input production is used throughout this report.

1.2.2 Geographical Distribution. Tanning is one of the oldest industries in this country, beginning in the New England and Middle Atlantic States (EPA Regions I, II, and III) during colonial times. The greatest concentration of tanneries is still found in these areas. During the 19th and 20th centuries, tanneries have tended to follow the source of their raw materials--cattlehides. This gave rise to the location of tanneries west of the Mississippi River. Currently, there are tanneries in 34 states. Figure 1 illustrates the geographical distribution of tanneries in the nation. As shown, approximately 30 percent of all tanneries are located in New York (EPA Region II) and Massachusetts (EPA Region I), and 85 percent of all tanneries are located east of the Mississippi River.

FIGURE 1

DISTRIBUTION OF TANNERIES


WA 2
OR 4
CA 14
ID
NV
MT
WY
UT 1
AZ 1
CO 4
NM
ND
SD
NE 1
KS
OK
TX 4
MN 4
IA 2
MO 3
AR
LA 1
WI 21
IL 11
MI 3
IN 2
OH 4
KY 3
TN 9
MS
AL
GA 1
FL 3
SC
NC 3
VA 2
WV 2
PA 14
NY 40
VT - 1
ME 9
NH - 14
MA - 79
RI
CT
NJ - 25
DE - 3
MD - 1
AK: 1
HI: 0
▨ States Containing No Tanneries

1.2.3 Categorization Criteria. A combination of criteria was used to categorize the tanning industry with respect to its total process solid waste and potentially hazardous solid waste generation. Major differences are apparent between the two predominant types of tanning processes--chrome tanning and vegetable tanning. Within the chrome tanning category, processing differences based upon the raw material (type of hide or skin) used and the type of finished leather produced yielded additional categories. A major operation conducted on a contract basis is the finishing of leather. No actual tanning is conducted by these establishments, and thus finishing is another tannery category.

Trends in the industry were also taken into account in the establishment of industry categories. Recently, operational changes in the most common type of tannery (complete chrome) have given rise to the development of two new types of operations: the beamhouse/tanhouse facility and the retan/finisher. Essentially, these are the operations carried on in a complete chrome tannery with the processing of the hides through the tanning operation conducted in the beamhouse/tanhouse facility and the processes from retan through leather finishing conducted by the retan/finishers. Although these operations have been in existence for less than 20 years, they already account for about 10 percent of the total production in this country.[2] It is expected that this trend will continue.

In summary, the following industry categories were developed for purposes of this study.

Category	Rationale
Complete chrome tannery	The most common type of tanning operation in the United States; includes the chrome tanning of cattlehides and pigskins.
Vegetable tannery	The absence of chromium and other heavy metals in tanning and processing hides is unique to this segment of the industry.
Sheepskin tannery	The importation of partially processed sheepskins and unique sequence of processing yields waste streams notably different from the complete chrome tannery.
Split tannery	Specialized operations on previously tanned hides produce waste streams with higher generation rates than found in complete chrome tanneries and the lack of finishing operations eliminates one or more waste streams.

Category	Rationale
Leather finisher	Usually a contract operation specializing in the finishing of leather with no tanning facilities. Finishers normally have only one or two of the waste streams found in the complete chrome tannery.
Beamhouse/tanhouse facility and Retan/finisher	The two "halves" of the complete chrome tannery. A trend towards separating tanning operations geographically with partial processing near the source of the raw material and completion in another location gives rise to these two categories.

1.3 Waste Characterization

1.3.1 Process Solid Wastes. Pieces of leather (containing 10 to 50 percent moisture) in various stages of processing, and wastewater treatment sludges constitute the bulk of the process solid wastes from tanneries. In order to produce the quality products required by leather consuming industries, tanneries trim off inferior portions of hides at many steps in processing. Smaller pieces of leather wastes are produced in shaving and buffing operations. Approximately 35 percent of all tannery solid waste is trimmings and shavings of various types.

Another source of tannery wastes is the finishing department. Finishes are sprayed or rolled onto leather and the residue is considered to be a solid waste since it is land disposed. Finish residues are usually slurries containing 10 to 50 percent solids. Waste finishes account for about 2 percent of tannery solid waste.

Wastewater treatment is the single largest source of process solid waste. Almost all tanneries screen their wastewater. Direct dischargers and some discharging wastewater into municipal sewers have some form of primary or secondary treatment (only direct dischargers use secondary treatment). The screenings and sludges from these operations contain lime, chromium compounds, pieces of leather, hair, and other protein-like substances which are land disposed. Wastewater screenings and sludge account for about 60 percent of tannery solid waste.

Floor sweepings are the final source of process solid waste. These include twine used to tie bundles of hides, salt used to preserve the hides prior to tanning, and general plant debris. Approximately 3 percent of tannery solid waste is floor sweepings.

Tables 1 through 3 provide estimates of the state, EPA Region, and national quantities of tannery process solid waste destined for land disposal. The data presented is based on the quantity of solid waste generated at the 41 tanneries visited (in units of kg per equivalent hides). Data for states with less than three tanneries has been combined in order to protect the confidentiality of production information.

As shown in Table 1, more tannery process solid wastes and potentially hazardous solid wastes are generated in Massachusetts than in any other state, followed by Wisconsin and New York. Similarly, approximately one-half of the total process and potentially hazardous solid waste generation occurs in EPA Regions I and V. Minor amounts of solid waste are generated in EPA Regions VI, VIII, and X. In most states, the potentially hazardous solid waste generated represents about 90 to 95 percent of the total process solid waste. Significant exceptions ot this pattern occur in states such as Pennsylvania, Georgia, Kentucky, and Virginia, where most or all of the production occurs in vegetable tanneries. As discussed below, vegetable tanneries do not generate potentially hazardous solid waste.

Figure 2 diagramatically shows the relative quantity of potentially hazardous waste currently (1974) generated in each state. As indicated, Massachusetts and Wisconsin are the only states which generate more than 20,000 metric tons per year, and California, New York, and Maine are the only three states which generate between 10,000 and 20,000 metric tons per year. Tennessee is the only southern state (EPA Regions IV and VI) which generates more than 1,000 metric tons per year. West Virginia, Georgia, and Indiana have only vegetable tanneries and therefore do not generate potentially hazardous solid waste.

Tables 2 and 3 show the distribution by state of total process and potentially hazardous waste generation projected for 1977 and 1983, respectively. As indicated, waste generation is projected to increase gradually through 1983 in all states except those with a large proportion of vegetable tanneries. This trend is anticipated since production of chrome tanned cattlehides and pigskins is expected to increase, while vegetable tanned and sheepskin leather production is expected to decline. In addition, the proportion of total process solid waste which is potentially hazardous is projected to increase slightly as a result of increasingly stringent wastewater pretreatment and direct discharge standards. Most new wastewater treatment facilities are projected to be installed at complete chrome tanneries and beamhouse/tanhouse facilities. Consequently, increases in the portion of total process solid waste which is potentially hazardous will be most notable in states with a high proportion of other types of tanneries (vegetable tanneries, leather finishers, etc.), such as Pennsylvania.

TABLE 1

TOTAL PROCESS AND POTENTIALLY HAZARDOUS SOLID WASTE GENERATED BY ALL TYPES OF TANNERIES IN 1974 (metric tons per year, wet and dry basis)

State(s)	Production (thousands of equivalent hides)	Total Process Solid Waste		Total Potentially Hazardous Wastes	
		Wet	Dry	Wet	Dry
AK,WA	28	192	61	177	48
AZ,CA	1,870	13,200	4,380	12,200	3,620
CO,UT	221	2,093	562	2,025	496
DE	230	649	212	589	162
FL,GA	169	1,950	442	61	18
IL	1,630	7,500	2,490	6,900	2,000
IN,OH	200	1,390	332	184	51
IA,NE	512	4,690	2,250	4,560	1,100
KY	437	5,480	1,210	0	0
LA,TX	107	846	227	626	158
ME,VT	2,630	13,100	4,430	11,200	3,420
MD,VA,WV	1,150	14,300	3,180	132	36
MA	8,273	31,900	13,000	29,600	11,200
MI	1,147	7,880	2,490	7,250	1,970
MN	898	6,430	1,980	5,980	1,590
MO	774	7,870	2,030	7,380	1,660
NH	1,670	10,100	3,370	9,260	2,710
NJ	1,340	3,480	1,130	3,190	885
NY	4,020	16,200	5,650	14,600	4,320
NC	211	2,420	238	3	1
OR	115	904	262	600	163
PA	1,860	16,000	4,210	5,570	1,580
TN	1,230	8,481	2,380	4,620	1,280
WI	4,980	25,900	8,500	23,800	6,730
Total	35,700	203,000	65,000	151,000	45,200
Region I	12,600	55,100	20,800	50,100	17,300
II	5,370	19,700	6,780	17,800	5,220
III	3,240	31,000	7,600	6,290	1,780
IV	2,040	18,300	4,270	4,680	1,300
V	8,850	49,100	15,800	44,100	12,300
VI	107	846	227	626	158
VII	1,290	12,570	4,280	11,900	2,770
VIII	221	2,090	562	2,020	496
IX	1,870	13,200	4,380	12,200	3,620
X	143	1,100	322	777	211

Source: SCS Engineers, except production information, which is from Tanners' Council of America.

Note: Totals may not add due to rounding.
Production is based on the sum of all hides put into processing at all seven types of tanneries.

TABLE 2

TOTAL PROCESS AND POTENTIALLY HAZARDOUS SOLID WASTE GENERATED BY ALL TYPES OF TANNERIES IN 1977 (PROJECTED)
(metric tons per year, wet and dry basis)

State(s)	Total Process Solid Waste		Total Potentially Hazardous Wastes	
	Wet	Dry	Wet	Dry
AK,WA	215	68	220	54
AZ,CA	14,900	4,920	13,700	4,100
CO,UT	2,581	689	2,528	612
DE	717	232	625	180
FL,GA	1,840	417	68	19
IL	8,350	2,750	7,440	2,240
IN,OH	1,340	321	225	56
IA,NE	5,840	1,530	5,700	1,380
KY	5,150	1,140	0	0
LA,TX	908	258	768	188
ME,VT	14,400	4,600	12,300	3,610
MD,VA,WV	13,500	3,000	165	40
MA	34,600	14,100	33,900	12,200
MI	8,790	2,760	8,040	2,210
MN	7,320	2,230	7,050	1,820
MO	9,600	2,470	8,660	2,080
NH	11,100	3,700	10,300	3,000
NJ	3,980	1,280	3,920	1,020
NY	17,600	6,110	17,000	5,030
NC	2,280	505	3	1
OR	964	281	749	183
PA	16,100	4,290	6,860	1,780
TN	8,850	1,840	5,740	1,430
WI	29,300	9,550	27,500	7,640
Total	220,000	69,100	173,000	51,000
Region I	60,100	22,450	56,500	18,800
II	21,600	7,390	21,400	6,050
III	30,300	7,520	7,750	2,000
IV	18,100	3,900	5,810	1,450
V	55,100	17,600	50,250	14,000
VI	908	258	768	188
VII	15,440	4,000	14,400	3,460
VIII	2,580	689	2,540	612
IX	14,900	4,920	13,700	4,100
X	1,180	349	969	237

Source: SCS Engineers

Note: Totals may not add due to rounding.

TABLE 3

TOTAL PROCESS AND POTENTIALLY HAZARDOUS SOLID WASTE GENERATED BY ALL TYPES OF TANNERIES IN 1983 (PROJECTED)

(metric tons per year, wet and dry basis)

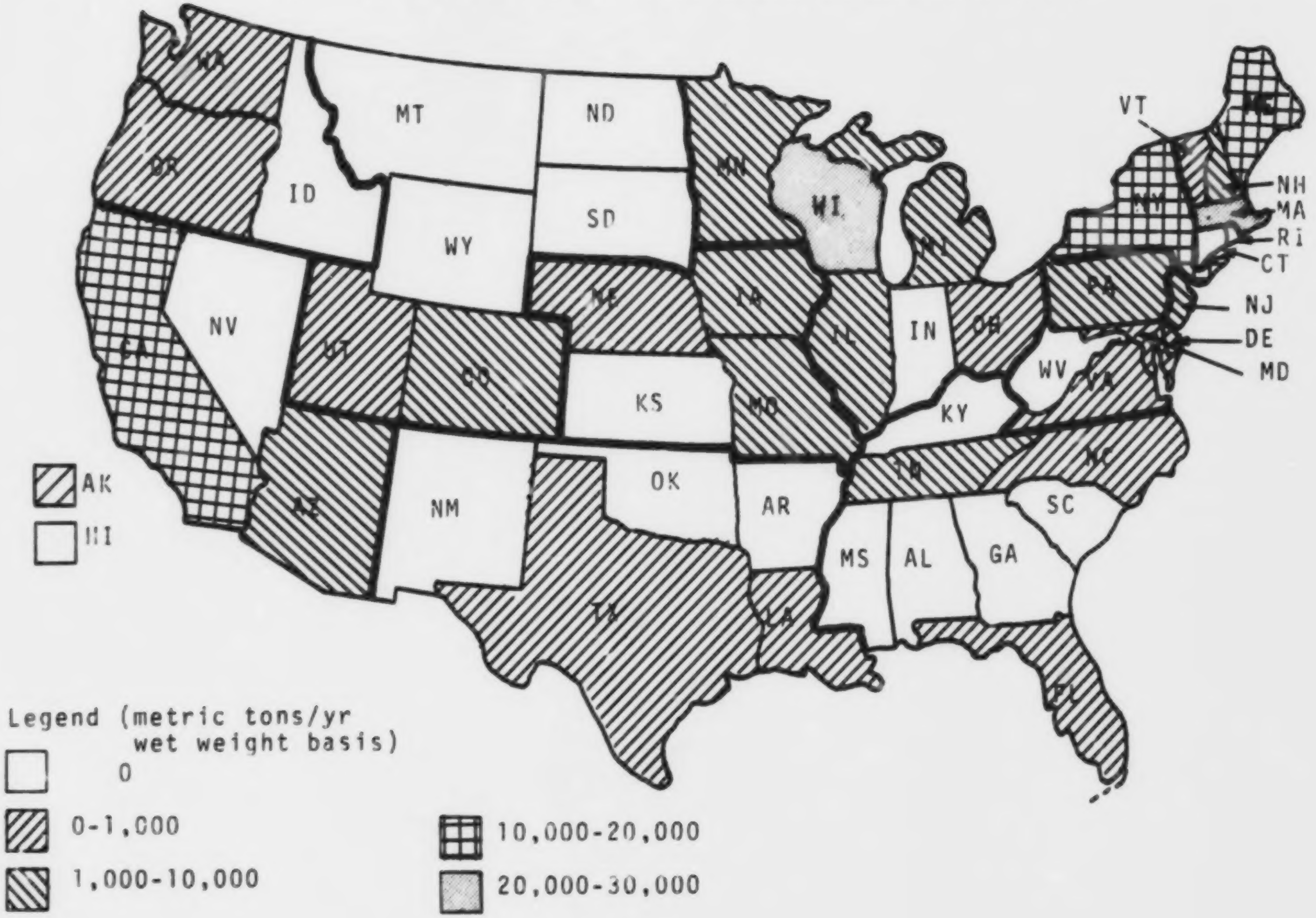
State(s)	Total Process Solid Waste		Total Potentially Hazardous Wastes	
	Wet	Dry	Wet	Dry
AK,WA	287	89	269	75
AZ,CA	20,200	6,540	19,100	5,600
CO,UT	4,000	1,053	3,890	949
DE	943	298	877	243
FL,GA	1,750	382	77	22
IL	11,100	3,580	9,670	3,020
IN,OH	1,344	317	269	75
IA,NE	9,130	2,390	8,890	2,140
KY	4,870	1,030	0	0
LA,TX	1,350	356	1,160	283
ME,VT	18,800	5,860	17,500	4,830
MD,VA,WV	12,800	2,260	200	55
MA	43,300	17,100	24,100	15,100
MI	11,700	3,640	11,000	3,040
MN	10,100	3,020	9,550	2,560
MO	14,600	3,780	13,600	3,270
NH	14,500	4,720	13,700	3,980
NJ	5,570	1,720	5,240	1,440
NY	22,900	7,690	21,100	6,260
NC	2,150	457	2	1
OR	1,200	348	912	252
PA	17,800	4,770	8,400	2,410
TN	10.600	3,010	7,010	1,960
WI	40,100	12,800	37,600	10,600
Total	281,000	87,700	214,000	68,200
Region I	76,600	27,700	55,300	23,900
II	28,500	9,410	26,300	7,700
III	31,500	7,800	9,480	2,700
IV	19,400	4,800	7,090	1,980
V	74,300	23,400	68,100	19,300
VI	1,350	356	1,160	283
VII	23,700	6,170	22,500	5,410
VIII	4,000	1,060	3,890	950
IX	20,200	6,540	19,100	5,600
X	1,490	437	1,180	326

Source: SCS Engineers

Note: Totals may not add due to rounding.

FIGURE 2

POTENTIALLY HAZARDOUS SOLID WASTE GENERATED IN 1974


WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
OK
TX
MN
IA
MO
AR
LA
WI
IL
MI
IN
OH
KY
TN
MS
AL
GA
FL
SC
NC
WV
VA
PA
NY
VT
ME
NH
MA
RI
CT
NJ
DE
MD
AK
HI
Legend (metric tons/yr wet weight basis)
0
0-1,000
1,000-10,000
10,000-20,000
20,000-30,000

It is also worth noting that a comparison of Figure 1 and 2 indicates a general correlation between the number of tanneries in a state and the quantity of potentially hazardous solid wastes generated. Variations from this general relationship occur principally due to concentrations of vegetable tanneries (which do not generate potentially hazardous wastes) and leather finishers (which generate relatively small amounts of potentially hazardous wastes), e.g., Pennsylvania and New York.

Chromium (III) is by far the most abundant potentially hazardous constituent found in tannery wastes. Lead, copper, and zinc are also present in the wastes. Estimates of the nationwide total quantities of these heavy metals generated in tannery wastes is shown below:

	Potentially hazardous constituents (metric tons per year)			
	Chromium (III)	Zinc	Lead	Copper
1974	909	0.46	10.6	16.9
1977	1,000	0.59	11.9	19.6
1983	1,300	0.94	14.7	28.0

1.3.2 Potentially Hazardous Wastes. "Potentially hazardous wastes" are defined as wastes or combinations of wastes, which pose a substantial present or potential future hazard to human health or living organisms because such wastes are lethal, non-degradable, or persistent in nature; may be biologically magnified; or otherwise cause or tend to cause detrimental cumulative effects.[3]

Many of the substances of particular concern in this study, primarily heavy metals, are prerequisites to life in trace quantities, but are toxic at higher concentrations. The uncertainty and confusion about what concentration levels are hazardous arises because:

- In the complete absence of certain elements, life cannot exist.
- There is a vaguely defined intermediate concentration range in which these substances are essential and/or can be tolerated.
- There is a higher level above which chronic and acute toxicity may result.

Definition of Potentially Hazardous Waste. Scientific studies of the environmental fate of tannery wastes following land disposal have not been conducted, and in many instances the chemical structure of tannery solid waste is not well understood. As a result, it was necessary to select a recognized reference for identifying the concentration level above which the presence of a hazardous constituent in tannery waste makes the waste potentially hazardous. As a guide as to what constitutes potentially hazardous concentration levels in wastes destined for land disposal, the geometric means of the background concentration levels in soils in the United States of the toxic heavy metals found in tannery wastes were used as the reference datum.[4]

Using this definition in conjunction with analyses of tannery waste samples, the types of tannery wastes which should be considered potentially hazardous were identified. Table 4 lists the various types of potentially hazardous wastes; the hazardous constituents present in each type at concentration levels above the mean concentration in soils; the results of tannery waste sampling and analyses; and the relevant background soil values. As shown, four types of tannery waste were identified which contain four hazardous constituents at potentially hazardous concentration levels, one type of waste with three hazardous constituents, one type of waste with two hazardous constituents, and two types of waste with a single hazardous constituent. Analyses were made for other heavy metals, pesticides, and phenols; however, none were found at potentially hazardous concentrations.

Several types of wastes which are not considered potentially hazardous were also identified. Plant floor sweepings and related miscellaneous solid waste were found to be non-hazardous in all types of tanneries. In vegetable tanneries, all types of solid waste generated are considered non-hazardous since hazardous constituents were not found at concentrations above the mean soil concentration. For example, copper was found at an average concentration of 13.4 ppm (dry weight) in wastewater treatment residues from four vegetable tanneries, whereas the geometric mean concentration in U.S. soils is 18 ppm (dry weight).

Discussion of Potentially Hazardous Wastes. Although the environmental effects of lead, zinc, and copper are not completely understood, the phototoxicity of zinc and copper to agricultural crops, the toxicity of lead to man, and the toxicity of all three elements to various aquatic organisms, is well established.

The only form of chromium of concern and interest in this study is trivalent chromium, since other forms of chromium are not used in the production of leather. The toxicological information on trivalent chromium, however, is conflicting. Some information is available on the effects of trivalent chromium on plants which generally indicates that low concentrations of trivalent chromium may be essential, or possibly even beneficial, whereas higher concentrations may be toxic. The effects vary with species and with the specific chromium compound. The effects on plant growth of adding chromium to the soil depend upon the

TABLE 4

POTENTIALLY HAZARDOUS TANNERY WASTES

			Analytical Results		
Waste Stream	No. of Samples	Hazardous Constituent*	Mean Concentration (wet weight-mg/kg)	Concentration Range** (wet weight-mg/kg)	Geometric Mean Concentration in U.S. Soils (dry weight-mg/kg)
Chrome (blue) trimmings & shavings	10	Cr^{+3}	7,600	2,200-21,000	37
Chrome fleshings	1	Cr^{+3}	4,000	----	37
Unfinished chrome leather trim	9	Cr^{+3}	16,900	4,600-37,000	37
		Cu	90	2.3-468	18
		Pb	120	2.5-476	16
		Zn	60	9.1-156	44
Buffing dust	12	Cr^{+3}	5,700	19-22,000	37
		Cu	960	29-1,900	18
		Pb	150	2-924	16
		Zn	160	----	44
Finishing residues	16	Cr^{+3}	3,500	0.45-12,000	37
		Cu	40	0.35-208	18
		Pb	8,400	2.5-69,200	16
		Zn	150	14-876	44
Finished leather trim	4	Cr^{+3}	14,800	1,600-41,000	37
		Pb	1,000	100-3,300	16
Sewer screenings	17	Cr^{+3}	2,200	0.27-14,000	37
		Pb	30	2-110	16
		Zn	60	35-128	44
Wastewater treatment residues (sludges)	27	Cr^{+3}	3,700	0.33-19,400	37
		Cu	370	0.12-8,400	18
		Pb	60	0.75-240	16
		Zn	50	1.2-147	44

Source: Laboratory analytical results and Reference 21

Note : Since tannery wastes are land disposed in a wet condition, i.e., containing moisture, reporting constituent concentrations on a wet weight basis realistically portrays the waste streams' chemical characteristics with respect to hazardous constituents. Constituent concentrations in U.S. soils were not available on a wet weight basis. Geometric mean values on a wet weight basis would be slightly less than those reported above. Thus the method of reporting the concentrations (wet or dry basis) does not impact on the designation of a waste stream as non-hazardous or potentially hazardous.

* For which analyses were made.

** Range not shown when only one sample was analyzed for the constituent.

amount of chromium naturally present in the soil. In some instances, crop yields have been improved by application of chromium to soils; conversely, a number of observations have been made of toxic effects of trivalent chromium on orange and corn seedlings, oat and corn plants, and tobacco.[4,5,6,7,8,9]

Similarly, trivalent chromium has been reported in the literature as toxic to a variety of aquatic species, including sticklebacks, flathead minnows, polycelisnigra (flatworm), Daphina and young eels.[6,9] However, recent attempts to repeat some of the earlier studies regarding the toxicity of trivalent chromium to sticklebacks and other fish have concluded that pH and/or the solubilizing agents used were the cause of the reported toxicity.[8]

As the preceding paragraphs have indicated, the existing information on the toxicity of trivalent chromium to plants and aquatic organisms is contradictory in many instances. However, trivalent chromium could ultimately be leached from tannery wastes, and since it is reported by some researchers as being toxic to various plants and aquatic organisms, trivalent chromium is considered to be a hazardous constituent of tannery solid waste.

1.4 Treatment and Disposal Technology

1.4.1 Treatment. Sludges from wastewater pretreatment/treatment facilities are the only potentially hazardous wastes which are currently treated prior to disposal. Treatment consists of dewatering the sludges. The only categories of tanneries with such facilities are the complete chrome tanneries and the beamhouse/tanhouse facilities. This is due to the fact that the beamhouse is the major source of suspended solids in a tannery.

Sludge dewatering is accomplished using gravity (sequential settling) or mechanical means. Three mechanical methods of sludge dewatering are used by tanneries--vacuum filters, centrifuges, and filter presses. All three are effective; however, there seems to be a preference for filter presses due to the slightly drier (40 percent solids) filter cake produced. Gravity dewatering systems are also used to a very limited extent, but the prevalence of this method of treatment appears to be declining. One of the largest gravity dewatering systems has recently been replaced with a filter press.

As restrictions on the wastewater discharges from tanneries become more stringent, more tanneries will install wastewater pretreatment facilities. This will lead to more widespread use of mechanical dewatering of the sludge generated. The complete chrome tanneries and the beamhouse/tanhouse facilities will be the two types of operations most likely to install sludge dewatering equipment.

Sludge dewatering is the only type of solid waste treatment applicable and appropriate for tannery wastes. No exotic treatment such as detoxification or chemical fixation is considered necessary.

1.4.2 Disposal. Approximately 60 percent of potentially hazardous tannery waste is disposed in landfills. "Sanitary landfills" (as defined by EPA which provide for engineered disposal and daily cover) accept 10 percent of the potentially hazardous tannery waste. Engineered landfills which do not provide daily cover accept about 25 percent of the waste. The remaining landfills are converted dumps. Open dumps accept about 25 percent of the waste. Dumps are most common in EPA Region I and are normally municipally owned. Most of these are being closed or converted to landfill operations.

Potentially hazardous waste (including sludge) is usually mixed with municipal refuse, compacted, and covered. At some disposal sites, wastewater treatment sludge is segregated and placed in trenches or lagoons. Operational problems include some reported difficulty in spreading and compacting large quantities of waste (particularly blue trimmings and shavings) that are mixed with municipal refuse.

Leaching of the heavy metals from potentially hazardous waste is the primray environmental concern associated with landfilling. A secondary problem is the flammability of some finishing residues; however, only small quantities of this waste are disposed at any one time.

The more advanced disposal technologies for potentially hazardous waste examined during site visits included lined trenches for wastewater pretreatment/treatment sludge, and State-certified hazardous waste dipsosal facilities.

Tanneries normally use the least expensive site available--normally a municipally-owned landfill or dump. Tannery-owned facilities are usually operated because of the plant's remote location or the fact that other disposal sites will not accept the waste (usually sludges). It is estimated that only 10 percent of all tanneries operate their own disposal sites.

Industry treatment and disposal technologies are classified herein as Level I, Level II, or Level III. Level I is the most common practice currently employed. Level II is the best technology currently employed. Level III treatment and disposal technology is that which provides adequate health and environmental protection. The technologies for these three levels of treatment and disposal, and the quantities and percentage of wastes going to each level of technology, for the six tannery categories generating potentially hazardous wastes are shown in Table 5. As indicated, Level III technology is currently (1974) used only in two categories of the industry, and only in situations where Level II and Level III are the same. Using the data in

TABLE 5

TREATMENT AND DISPOSAL TECHNOLOGY LEVELS AND
ASSOCIATED POTENTIALLY HAZARDOUS WASTE QUANTITIES

Category	Treatment/Disposal Technology			Current (1974) Distribution of Waste Between Treatment/Disposal Technologies					
	Level I	Level II	Level III	Level I		Level II		Level III	
				metric tons/yr (wet/dry)	%	metric tons/yr (wet/dry)	%	metric tons/yr (wet/dry)	%
Complete chrome tannery	Landfill	Dewater sludge, all waste disposed in certified hazardous waste disposal facility	Same as Level II, landfill with leachate collection	52,000/14,000	50	4,200/1,200	4	4,200/1,200	4
Sheepskin tannery	Landfill	Landfill	Landfill with leachate collection	2,500/800	60	2,500/800	60	0	0
Split tannery	Dump	Landfill	Landfill with leachate collection	11,200/5,500	70	4,800/2,400	30	0	0
Leather finisher	Landfill	Landfill	Landfill with leachate collection	540/180	60	540/180	60	0	0
Beamhouse/tanhouse facility	Dewatered sludge, disposed in landfill	Dewatered sludge disposed in lined trenches	Same as Level II, or landfill with leachate collection	12,600/3,000	60	4,200/1,000	20	4,200/1,000	20
Retan/finsher	Landfill	Landfill	Landfill with leachate collection	2,500/1,300	55	2,500/1,300	55	0	0

Source: SCS Engineers

Table 5 and correcting for the overlap between technology levels, it is estimated that 85 percent of tannery potentially hazardous waste is going to Level I technology, 10 percent to Level II, and 5 percent to Level III.

1.4.3 Alternatives to Disposal.

Municipal Sewage Treatment. Some tanneries are located in communities where most of the wastewater received at the municipal sewage treatment plant is discharged by tanneries. These situations are somewhat unique to the tannery industry and deserve mention.

This situation is particularly prevalent in New England (EPA Region I), where three tanneries were visited which provided 80 to 95 percent of the flow to municipal treatment facilities. In other New England and New York (EPA Region II) communities, up to 60 percent of the flow was contributed by tanneries. Thus, the municipalities were essentially treating tannery wastewater and generating and treating tannery sludge.

In the community in which the tannery contributed 95 percent of the flow, the primary treatment plant sludge was dewatered using centrifuges and disposed in trenches at the city's landfill. In the two other communities visited, the tanneries contributed about 80 percent of the flow. Both of the treatment plants were constructed recently and neither was producing any secondary sludge. Primary sludge was dewatered with centrifuges. One operation was disposing of the dewatered sludge in trenches, and the other treatment plant was stockpiling the sludge near the plant until a disposal site was found.

Source Reduction Through In-Plant Process Changes. There are several in-plant processing changes in use by varying numbers of tanneries. These changes primarily contribute to economic advantages and secondarily impact on waste generation. These processes are in various stages of development from experimental through pilot plant and full scale operation. However, none of the processes are in widespread use in any of the tannery categories, let alone the tanning industry as a whole.

It is doubtful that many of the in-plant processes will come into widespread use by 1983. The impression gathered from tannery officials during the course of this project was that tanning is considered an art. Each tanner feels that he knows the "tricks of the trade" as far as the production of his particular leather is concerned. Tanners strive to maintain a quality product of consistent color, texture, pattern, etc., in order to retain their established customers. Some tanners are not sure that they can reduce their chemical usage, use reformulated finishes, reuse chrome, etc., and still produce the same product, and thus are reluctant to make even minor changes in their processing. Therefore, tanners will move slowly in altering their processing procedures. Since the in-plant process changes are not applicable to nor likely to be adopted by all tanneries in a particular category, no attempt has been made to suggest them to the entire industry. Consequently, in-plant process changes which impact on the quantity or nature of potentially hazardous waste have not been included as any level of treatment/disposal technology.

Sale as By-products. Economic feasibility is currently the primary factor affecting by-product utilization of potentially hazardous waste. Following is a list of the types of potentially hazardous wasteswhich are currently saleable and by-product uses:

Waste stream	By-product use
Blue trim and shavings	Fertilizer Hog feed supplement Glue
Solvent-based finish residues	Solvent recovery
Leather trimmings	Glue Craftsman--small leather articles

With the exception of solvent recovery, by-product utilization of potentially hazardous waste is volatile and dependent upon location. The major type of potentially hazardous waste sold is blue trim and shavings. These are, and have been, sold to producers of fertilizer, animal feed supplements, and glue. These markets are apparently declining as evidenced by the fact that, within the last two decades, the number of fertilizer producers utilizing leather waste has been reduced from 28 to 3. In addition, glue manufacturing from leather waste has essentially ceased. However, tanneries located in the Midwest are able to sell their blue trim and shavings to a producer of fertilizer used principally in citrus groves and to a lesser extent in other orchards. Similarly, some tanneries also sell blue trim and shavings for use as a hog feed supplement. If possible, finsihed leather trimmings are sold to local craftsmen or foreign countries for the manufacturing of small leather goods.

Sale of potentially hazardous waste for by-product uses is encouraged as an alternative to disposal if the ultimate use of the waste is environmentally sound. Blue trim and shavings are considered potentially hazardous due to their high trivalent chromium content. Information in the literature indicates that trivalent chromium is hazardous to aquatic organisms and to lower forms of terrestrial plant life, but not to mammals and higher plant forms. Consequently, the use of blue trim and shavings as a hog feed supplement is approved by the U.S. Department of Agriculture (chromium content not to exceed 275 ppm). Similarly, the use of this waste as an orchard fertilizer can be beneficial as long as the application does not become excessive and ground and surface water pollution does not result from the practice. Use of the waste for other fertilizer applications, such as vegetable crops, must be studied further before the environmental adequacy of the practice is known.

1.5 Cost Analysis

The cost data presented in this report is based upon actual costs reported by tanneries, and from prices quoted by disposal contractors serving tanneries. As necessary, additional information is included from equipment suppliers, published literature, government sources, and SCS files.

All cost information is given in December 1973 dollars, and when necessary, have been adjusted to this basis using the Chemical Engineering (CE) Plant Cost Index. For purposes of comparing the total cost of potentially hazardous waste treatment and disposal for the tanning industry to the value added in manufacturing and the total value of shipments, the latter indicators were converted to December 1973 dollars using the wholesale price index furnished by the Bureau of Labor Statistics.

1.5.1 Treatment.

Sludges resulting from primary and/or secondary wastewater treatment at beamhouse/tanhouse facilities and some complete chrome tanneries are the only solid waste generated by the leather tanning industry which is treated prior to disposal. The only treatment is dewatering, and it is always conducted on-site. The annual cost for sludge dewatering at a typical complete chrome tannery with primary and/or secondary wastewater treatment or a typical beamhouse/tanhouse facility generating 10,000 kg of dewatered sludge per 1000 equivalent hides processed is $86,000 per year.

1.5.2 Disposal.

All of the typical plants for the six categories of tanneries which generate potentially hazardous solid waste utilize contractor service for hauling and disposal. Contractor hauling and disposal charges range from $2 per metric ton of waste for open dumping to $46 per metric ton for a State-certified hazardous waste disposal facility, depending upon the type of disposal utilized, the quantity of waste generated by a particular plant, and the type of waste. Landfill disposal of potentially hazardous waste is the most common disposal method in this industry, and costs a typical tannery $10 per metric ton.

1.5.3 Summary and Discussion. A summary of the cost estimates for the three levels of treatment and disposal technology for typical plants in the six categories of tanneries is presented in Table 6. As shown, there are significant differences in cost for the typical plants of the different categories of tanneries. These variations are due to a variety of factors, including:

- Plant production.
- Contractor hauling and disposal costs.
- Local and geological conditions.
- Urban or rural location.
- Equipment used.

Individual plant production varies widely for plants within a given category, especially for complete chrome tanneries, where the largest plant is more than 100 times as large as the smallest plant. For tanneries generating relatively small quantities of solid waste (a few hundred kilograms daily), the cost of solid waste treatment and disposal per metric ton of waste is approximately three times that of plants which generate quantities more typical of operations in most of the categories (more than one metric ton per day). The other factors mentioned above are all site specific considerations, and estimation of changes in cost must be made on a case-by-case basis.

As shown, the total annual cost for Level I and Level III is the same for a typical complete chrome tannery without primary and/or secondary wastewater treatment. Although the cost per metric ton of waste is higher for Level III, due to higher costs for disposal in a landfill with leachate collection, the total cost is the same since Level III assumes that trimmings and shavings are sold as a by-product.

For a complete chrome tannery with primary and/or secondary wastewater treatment, the total fixed cost is due entirely to sludge dewatering. Sludge dewatering accounts for approximately 90 percent of the increase in total annual cost for complete chrome tanneries with primary and/or secondary wastewater treatment, relative to complete chrome tanneries without wastewater treatment facilities. The other 10 percent of the increase in costs is the result of sludge disposal charges.

Two different Level III treatment and disposal technologies are shown for split tanneries. The more expensive Level III technology (Alternative 1) is based on disposal of the waste in a landfill with leachate collection. The less expensive Level III technology (Alternative 2) costs are based on the sale of trimmings and shavings and the disposal of other potentially hazardous waste. The large difference in the total cost of these two alternatives arises because blue trimmings and shavings represent 90

TABLE 5

SUMMARY OF TREATMENT AND DISPOSAL COSTS FOR THE TYPICAL TANNERIES

Category	Cost Item	Level I ($)	Level II ($)	Level III ($) Alt. 1	Level III ($) Alt. 2
Complete Chrome Tannery without sludge (Production = 260,000 equivalent hides/year)	Total Fixed	None	None	None	---
	Total Annual	13,000	10,000	13,000	---
	Cost/1000 equivalent hides	46	38	46	---
	Cost/metric ton of waste*	10	10	14	---
Complete Chrome Tannery with sludge (Production = 260,000 equivalent hides/year)	Total Fixed	304,000	304,000	304,000	304,000
	Total Annual	119,400	131,000	131,000	125,500
	Cost/1000 equivalent hides	451	504	504	482
	Cost/metric ton of waste*	37	46	46	44
Sheepskin Tannery (Production = 200,000 equivalent hides/year)	Total Fixed	None	None	None	---
	Total Annual	6,700	6,700	8,100	---
	Cost/1000 equivalent hides	34	34	40	---
	Cost/metric ton of waste*	20	20	24	---

TABLE 6
(Continued)

Category	Cost Item	Level I ($)	Level II ($)	Level III ($)	
				Alt. 1	Alt. 2
Split Tannery (Production = 400,000 equivalent hides/ year)	Total Fixed	None	None	None	None
	Total Annual	7,000	3,600	48,000	4,300
	Cost/1000 equivalent hides	17	9	121	11
	Cost/metric tons of waste*	2	20	14	24
Leather Finishers (Production = 225,000 equivalent hides/ year)	Total Fixed	None	None	None	---
	Total Annual	1,100	1,100	1,500	---
	Cost/1000 equivalent hides	4.9	4.9	6.6	---
	Cost/metric ton of waste*	31	31	41	---
Beamhouse/tanhouse facility (Production = 300,000 equivalent hides/ year)	Total Fixed	304,000	304,000	304,000	304,000
	Total Annual	115,800	121,800	121,800	129,800
	Cost/1000 equivalent hides	390	406	406	426
	Cost/metric ton of waste*	38	41	41	43

TABLE 6
(Continued)

Category	Cost Item	Level I ($)	Level II ($)	Level III ($) Alt. 1	Level III ($) Alt. 2
Retan/finisher (Production = 675,000 equivalent hides/year)	Total Fixed	None	None	None	None
	Total Annual	12,000	8,000	17,000	9,000
	Cost/1000 equivalent hides	18	12	25	13
	Cost/metric ton of waste*	10	20	14	24

Source: SCS Engineers

* Wet weight basis.

percent of the waste generated by a typical split tannery. The cost per metric ton of waste actually disposed for Alternative 2 is increased due to the substantially reduced quantity of waste which must be collected and disposed.

A typical leather finisher generates less solid waste than any other type of tannery. Consequently, the annual contract hauling and disposal costs for all three levels of technology are less than for any other categories. However, the cost per metric ton is higher than for most other categories due to the small volumes of waste which must be collected and disposed.

Since wastewater treatment sludge is the only potentially hazardous waste generated by a typical beamhouse/tanhouse facility, all costs shown are the result of treatment and disposal of sludge. The cost of treatment and disposal for the most expensive Level III (Alternative 2) is only about 10 percent higher than for Level I. However, since about 90 percent of the total annual cost is the result of sludge treatment, which is the same for all levels of technology, the percentage increase in total cost to go from Level I to Level III technology is not very substantial.

Table 7 summarizes the total costs of treatment and disposal for each category of tannery and illustrates the differences in costs discussed above. For complete chrome tanneries with primary and/or secondary treatment sludge, approximately 90 percent of the total annual treatment and disposal costs are the result of wastewater treatment sludge. For beamhouse/tanhouse facilities, 100 percent of the treatment and disposal costs are the result of wastewater treatment sludge. As a result, approximately 65 percent of the cost of treatment and disposal for the total industry for all three technology levels is a result of wastewater sludge dewatering and disposal. For complete chrome tanneries without primary and/or secondary wastewater treatment sludge, the total annual treatment and disposal costs for all levels of technology are substantially higher than for other categories such as sheepskin, split tanneries, retan/finishers and leather finishers because the production of the complete chrome category is many times larger.

Another important factor effecting the cost of treatment and disposal technology for the total industry is the ability of complete chrome tanneries (without primary sludge), retan/finishers, and split tanneries to sell trimmings and shavings as a by-product. For these three categories of tanneries, the cost of treatment and disposal is less for Level II (with sale) than Level I (without sale), with the result that the total cost to the industry of Level I technology is virtually the same as for Level II. Similarly, the difference in cost between the most and least expensive Level III technology is primarily a function of whether trimmings and shavings are sold or land disposed.

TABLE 7

ANNUAL TREATMENT AND DISPOSAL COSTS
(Dec. 1973 dollars)

Tannery Category	Level I	Level II	Level III Least costly	Level III Most costly
Chrome w/ sludge	1,524,000	1,702,000	1,629,000	1,702,000
Chrome w/o sludge	675,000	519,000	675,000	675,000
Sheepskin	84,000	84,000	101,000	101,000
Split	60,000	31,000	37,000	411,000
Leather finisher	27,000	27,000	37,000	37,000
Beamhouse/ Tanhouse Facility	812,000	854,000	854,000	896,000
Retan/ Finisher	37,000	25,000	28,000	53,000
Total	3,219,000	3,242,000	3,361,000	3,875,000

Source: SCS Engineers

Using the distribution of production between the various categories observed in 1974, the value added in manufacturing (in December 1973 dollars) during 1974 was $480 million, and total value of shipments was $1,010 million. Thus, the costs of the three levels of treatment and disposal technology compared to the value added in manufacturing and the value of shipments are as follows:

Technology level	Treatment and disposal cost--percent of value added	Treatment and disposal cost--percent of value of shipments
I	0.67	0.32
II	0.68	0.32
III (least costly alternatives)	0.70	0.33
III (most costly alternatives)	0.81	0.38

Thus, it appears that there is little difference in the overall costs between Level I and Level III technologies (Table 7) and also in relative costs as percentages of value added and value of shipments (as tabulated above). These figures are industry-wide averages, and the impact on individual tanneries may be quite different than shown.

SECTION 2.0

INDUSTRY CHARACTERIZATION

2.1 The Tanning Industry

2.1.1 Introduction to Tanning. Tanning, one of the oldest arts known to man, is the process of converting the skins and hides of animals into leather. Pictures carved by Egyptians over 5,000 years ago depict tanning operations. The Greeks had developed leather making into a well established trade by the year 500 BC and in the 12th century, tanners' guilds were organized in England and Europe to regulate the manufacturing processes and advance the art of leather making.[10]

Tanning involves a complex combination of mechanical and chemical processes. The heart of the process is the tanning operation itself in which organic or inorganic materials become chemically bound to the protein structure of the hide and preserve it from deterioration. The substances used to accomplish the tanning process for viturally all of the leather produced in this country are chromium or extracts from the bark of trees, such as chestnut. These tanning agents give rise to the two predominant types of tanning operations--chrome and vegetable tanning.

Chrome Tanning. Approximately 85 percent of the leather produced in this country is chrome tanned.[2] Chrome tanning produces leather better suited for certain applications, particularly for the upper parts of boots and shoes, and requires less processing time than traditional vegetable tanning.

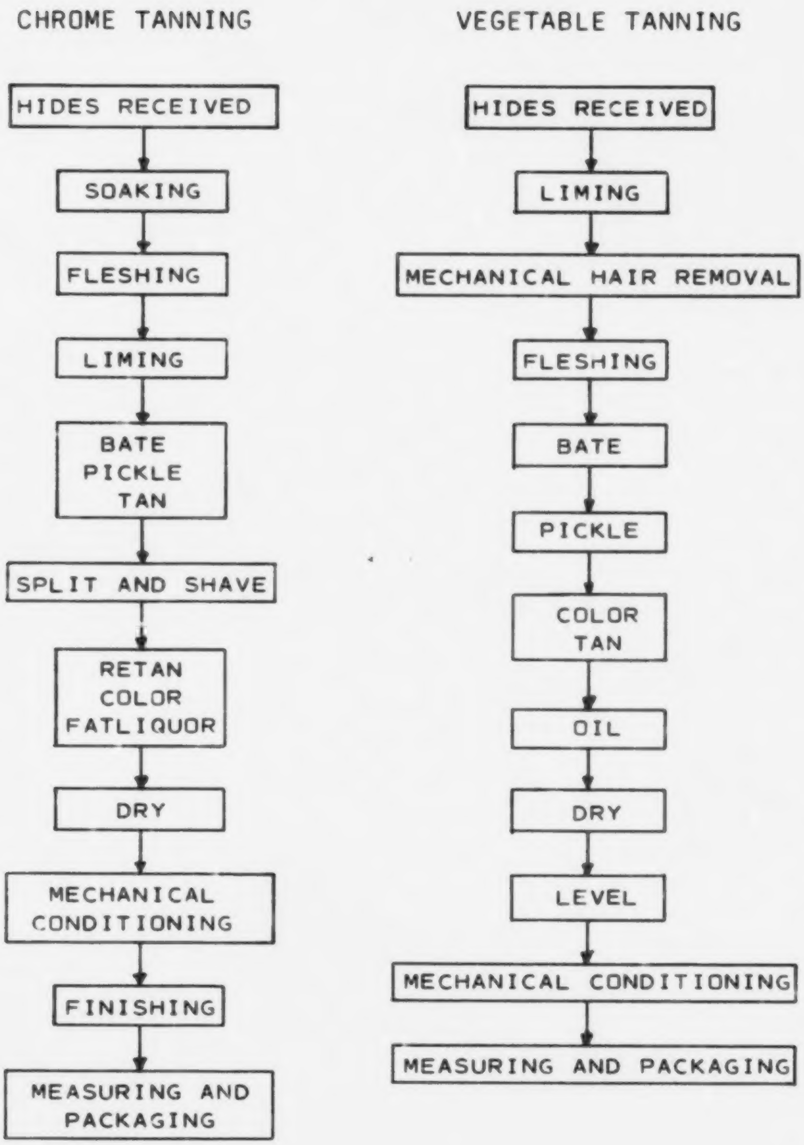
While cattlehides are the most common raw material for chrome tanning; sheepskins, calfskins, pigskins, and other hides and skins are tanned in this manner. It should be noted that the terms "hides" and "skins" refer to the entire skins removed from an animal and used as a raw material for tanning. "Hide" is used for large animals, e.g., cattlehide, horsehide. "Skin" is used for smaller animals, e.g., pigskin, sheepskin, calfskin. The term "hide" will be used hereafter unless a specific type of hide or skin is being discussed.

The general steps required for chrome tanning of leather are shown in Figure 3 and described briefly below. No two tanneries are identical; each has its unique characteristics and subprocesses; some perform only some of the processes shown and ship their goods to another tannery to complete the processing. The following description is intended to be illustrative and to provide the layman with a general

Preceding page blank

FIGURE 3

TYPICAL TANNING PROCESS STEPS


CHROME TANNING
HIDES RECEIVED
SOAKING
FLESHING
LIMING
BATE
PICKLE
TAN
SPLIT AND SHAVE
RETAN
COLOR
FATLIQUOR
DRY
MECHANICAL CONDITIONING
FINISHING
MEASURING AND PACKAGING
VEGETABLE TANNING
HIDES RECEIVED
LIMING
MECHANICAL HAIR REMOVAL
FLESHING
BATE
PICKLE
COLOR
TAN
OIL
DRY
LEVEL
MECHANICAL CONDITIONING
MEASURING AND PACKAGING

understanding of the major processing steps.

Hides and skins are received from meatpacking plants by truck or railroad car. Each cattlehide is tied in a bundle weighing approximately 25 kg. The bundles are cut open and the hides unfolded, inspected, and usually split along the backbone, producing two sides from each hide.

Next follows a sequence of wet operations. The sides are soaked in water to return some of the lost natural moisture. The remaining flesh or fatty substance adhering to the inside or flesh surface of the side is removed; these fleshings are usually either rendered in the tannery or sold. The cattlehides are then soaked in a lime and sulfide solution which either loosens or dissolves the attached hair. In some operations, the hair is only loosened through the caustic action of the lime with the hair removed mechanically, followed by washing, drying, and sale as a by-product (for carpet pads or similar uses). However, the more common approach for hair removal is to completely dissolve the hair and discharge it to the wastewater stream.

Following hair removal, the hides are ready to be prepared for the actual tanning operation. The hides are placed into large rotating drums and are treated in turn with an enzyme solution and then a salt-acid solution. These operations (called bating and pickling respectively) prepare the hide for the tanning process. While still in the drum after the discharge of the pickling solution, the hides are tanned. A chromium sulfate solution is added to the drum and the hides and chrome solution are mixed for periods of up to 24 hours.

Following chrome tanning, all hides have a characteristic blue color caused by the chrome tanning solution. Upon removal from the tanning drums, excess moisture is removed from the hides through a wringing operation.

Cattlehides are too thick for most purposes and therefore the tanned hides are split, using a machine similar to a horizontal band saw. The splitting operation produces a grain side of more or less uniform thickness. One surface of this grain side is the original outer surface of the cattlehide and retains the natural grain. The splitting operation also yields a thin, inner portion of the hide known as a "split" or "blue drop." Splits have no graining and are often used for suede garments. Both the grain side and the split may be further processed to form a piece of material of uniform thickness. This operation is called shaving and results in the removal of small pieces of leather with a consistency similar to very coarse sawdust.

Another series of wet operations gives the leather the color and other properties desired in the finished material. The tanned hides are placed into another drum for retanning, coloring and fatliquoring. Retanning is a second, shorter tanning operation normally using a tanning agent other than chromium. After the retanning solution is discharged from the drum, a pigment is added in order to dye the leather to the desired color. The coloring solution is also discharged from the drum. Next a mixture of oils is added and the hides and oil are rotated in the drum. This operation, called fatliquoring, helps to produce the desired softness.

After removal from the retan, color, and fatliquor drum, the leather is dried and physically conditioned. The two most common approaches to this conditioning are staking and buffing. Staking is a form of massaging which makes the leather more plyable. Buffing is a light sanding operation applied to either the grain surface or the underside of a piece of leather. It is used to improve the nap of the underside or to smooth out surface imperfections on the grain surface.

One or more of several possible finishing steps are then accomplished to give the leather the required pattern gloss, or waterproof qualities. Usually all leather receives at least one coat of a liquid finish material. Finishes are either rolled or sprayed onto the leather. These operations are followed by drying. Often three or more coats of finish are applied to leather; each is followed by a drying cycle. Other finishing operations include embossing, in which patterns are pressed into the leather surface. Finally, the surface area of each piece of leather is measured electronically and the area stamped on the underside. The leather is then packaged and stored for shipment.

Vegetable Tanning. Vegetable tanning employs the use of extracts from the bark of various trees as the tanning agent. Since the introduction of chrome tanning, vegetable tanning has decreased in importance. Soles of shoes have been traditionally vegetable tanned; however, since the introduction of synthetic materials for shoe soles, vegetable tanning has further decreased in importance. Vegetable tanning is the process by which most leather shoe soles are tanned, and it is also used to produce leather used in crafts.

Many of the basic steps used in the chrome tanning process are also present in vegetable tanning. The sequence in which these steps are employed is somewhat different, and there are few finishing operations associated with vegetable tanning. A processing diagram for vegetable tanning is also shown in Figure 3.

The processing of hides prior to vegetable tanning begins with a soak in a lime solution to loosen the hair. Hides are then removed from the lime solution and the hair removed mechanically. The hides are then soaked and rinsed, and the fleshing operation is accomplished. Note that in the chrome tanning process, fleshing preceded the hair removal operation.

After fleshing, the hides are trimmed into a roughly rectangular shape and then passed through a bate and pickle operation similar to that used in the chrome tanning process. Coloring, the next operation, is often done utilizing a weak tanning solution. Normally vegetable tanned leather is not highly colored. After coloring, the hides are placed into vats containing the bark extract tanning solution and moved from a strong tanning solution to a slightly weaker one, then rinsed and partially dried.

True splitting is not usually a part of the vegetable tanning process; however, an operation called leveling is used to produce a uniformly thick piece of leather. Leveling removes only the thickest portions of the underside of the hide, and no "split" is produced. Next, the hide is oiled, which is a process similar to the fatliquoring in chrome tanning. Following oiling, the hide is dried and then mechanically conditioned.

Virtually no finishing is done at vegetable tanneries. Few, if any, spray finishes are applied and often the only finishing process employed is pressing to yield a smooth grain surface. Finally, the hides are measured, packaged, and stored prior to shipment.

2.1.2 Background.

History in the United States. Tanning is one of the oldest arts known in this country. Early explorers and colonists noted that the Indians knew and practiced the art of leather tanning. Early colonial tanneries were begun in the New England States in the 1600's. Shortly after colonial times, tanneries continued to be established in the New England States and also in rural locations close to the source of the bark necessary for the tanning solutions. During the 19th and 20th centuries, tanneries moved west following the westward movement of cattle. Today, leather tanning and finishing plants are located in 34 states. However, tanneries are still concentrated in their traditional areas of New England and the Middle Atlantic States.[2]

Magnitude of the Industry. For the purposes of this report, there are 298 different establishments in the leather tanning and finishing industry which have production facilities.[2] This is 219 less than the number reported by the Bureau of the Census.[1] The difference arises from the accounting methods used by the Bureau of the Census and from interpretation as to which operations constitute actual production activity. First, the Bureau of the Census data includes 76 converters. These operations were not included as part of this industry study because the converters have no production facilities. They perform such functions as warehousing, contract measuring, and shipping. A second difference concerns small operations. Establishments with one to four employees are usually considered to be taxidermists or hobbyists and are not truly part of the leather tanning and finishing industry. Finally those companies conducting two or more activities from the same location and other instances (not counted as converters) where no production facilities exist were eliminated. The Bureau of the Census requires reports from companies engaging in different lines of activity at one location. This duplication has been eliminated. Similarly, one-man sales offices and the like were subtracted from the Bureau of the Census figures. An alphabetical listing of the remaining establishments, including their name and address, is included as Appendix A.

Tanneries tend to be small when measured by the number of employees. As noted above, the smallest operation considered to be a viable part of the industry has at least five employees. The largest plant in the industry employs about 500 workers. Only 87 plants employ more than 100 workers.[2]

The facilities in which tanning operations are conducted tend to be old. The majority of the plants are more than 50 years old, and few completely new plants have been built in the last two decades.[2] The age of plants in the tanning and finishing industry is distributed as follows[2]:

Age of plant	Percent of plants
Less than 10 years	1
10 to 14.9 years	1
15 to 19.9 years	3
20 to 29.9 years	4
30 to 50 years	18
Over 50 years	67
Data not available	6
	100

Production in the tanning industry is normally measured in terms of equivalent hides. An equivalent hide has an area of 3.7 m^2 (40 ft^2). Production in 1974 by state is shown in Table 8. In order to protect the confidentiality of production information, states are combined when there are less than three tanneries in a state. As shown, Massachusetts has the most production, followed by Wisconsin and New York. The total production of 35.7 million equivalent hides represents the sum of the hides processed by the seven types of tanneries discussed in Section 2.2.6. Cattlehides accounted for approximately 90 percent or 32.1 million equivalent hides with the remaining 3.6 million made up of sheep, pig, and calfskins and all others.[2]

TABLE 8

1974 TANNERY PRODUCTION BY STATE

State(s)	Production (thousands of equivalent hides put into processing)
Alaska, Washington	28
Arizona, California	1,870
Colorado, Utah	220
Delaware	230
Florida, Georgia	169
Illinois	1,630
Indiana, Ohio	200
Iowa, Nebraska	512
Kentucky	437
Louisiana, Texas	107
Maine, Vermont	2,630
Maryland, Virginia, West Virginia	1,150
Massachusetts	8,270
Michigan	1,150
Minnesota	898
Missouri	774
New Hampshire	1,670
New Jersey	1,340
New York	4,020
North Carolina	211
Oregon	115
Pennsylvania	1,860
Tennessee	1,230
Wisconsin	498
Total	35,700
Region I	12,600
II	5,370
III	3,240
IV	2,040
V	8,850
VI	107
VII	1,290
VIII	221
IX	1,870
X	143

Source: Tanners' Council of America
Note: Totals may not add due to rounding.

Value of shipments is another indicator of the magnitude of an industry. The Bureau of the Census reports the value of shipments for the leather tanning and finishing industry in 1967 as $846 million and in 1972 at $1,026 million.[1] The Tanners' Council estimates the value of shipments in 1974 also at $1,026 million and in 1975 at $1,118 million.[2] Information on the value of shipments is not available on a state-by-state basis.

Geographical Distribution. Although there are leather tanning and finishing establishments in 34 states, the industry is not widely dispersed. Table 9 illustrates the number of tanning and finishing operations in each of the states. The industry's geographical concentration has been determined by factors affecting population concentrations and the locations of the sources of raw materials, i.e., meatpacking facilities. Major regional areas in which tanneries are concentrated:

New England (EPA Region I)--Massachusetts, Maine, and New Hampshire
Middle Atlantic (EPA Regions II and III)--New York, New Jersey, and Pennsylvania
North Central (EPA Region V)--Wisconsin, Illinois, and Minnesota
Pacific (EPA Region IX)--California

2.1.3 Industry Organization and Structure. The leather tanning and finishing industry in the United States consists almost exclusively of family-owned businesses. Few corporations own more than one tannery. Only one firm is listed on a stock exchange, and only a handful of companies are subsidiaries or operating divisions of larger corporations. Approximately nine tanneries are subsidiaries of larger firms not primarily associated with the leather industry. One tanning company is a subsidiary of a meatpacking company while three shoe manufacturers have their own tanning facilities.[2]

The industry is not characterized by an appreciable integration, either back to raw material supply or forward to finished or fabricated leather products. Thus, tanneries are not owned by leather product manufacturers, and they do not tend to own sources of their raw material. Similarly, the ownership of the tanneries by shoe manufacturers is not common. In recent years there has been a trend to even less integration. One major meatpacking firm and one leading shoe manufacturer recently divested their tanning operations. Thus, only the previously mentioned single instance of a meatpacker-tannery combination and three examples of direct connections between tanneries and shoe manufacturers remain.

Tanneries tend to be specialized in the type of raw material processed and leather produced. The first reason for this lack of diversification stems from the fact that tanning equipment and processes are specialized and not readily interchangeable in terms of raw material and end product. For example, some equipment suitable for the tanning and finishing of pigskins or sheepskins cannot be used for the larger cattlehides. The second reason is the fact that shoe manufacturing has been and still is the principal consuming industry. In 1962, shoes accounted for 83 percent of all leather used. This ratio declined to 74 percent in 1972.[2] This caused some tanneries to seek some diversification in their production. Tanneries specializing in leather for the upper parts of shoes (often called side leather tanneries) attempted to modify their production techniques in order to enter the growing garment leather market. However, this trend does not reflect diversification of basic product line. Rather, it indicates an effort to adapt available plant and equipment to moderately different end use requirements.

2.1.4 Industry Trends and Future Developments.

Character and Quantity of Raw Material Supply. In the United States there has been a large increase in the number of cattlehides and pigskins that have become available for processing into leather. This has been accompanied by a sharp decline in the availability of sheep, goat, and calfskins.[2]

Increased consumption of beef has lead to a rise in the number of cattlehides available for tanning. This number has increased from 28 million hides anually to 38 million in the period from 1957 to 1974.[2] In the United States, until recently, very few pigskins have been removed from the animal prior to processing for meat. There are indications that economic considerations are leading to the removal of more pigskins prior to butchering, and it is estimated that in 1974 as many as 4 million pigskins were available for tanning.[2]

Concurrent with the increase in cattlehide and pigskin supply in the United States, there has been a corresponding decrease in the availability of goat and kidskins, sheep and lambskins, and calfskins. Skins from goats and sheep have been traditionally imported; however, it has become the policy of the nations supplying most of these skins to encourage the utilization of the skins locally, thus leaving few skins available to U.S. tanners. Production of leather from these skins has declined drastically in this country. Goat and kid leather production was over 22 million skins (about 3.3 million equivalent hides) in 1957 and practically zero in 1974. Sheep and lamb leather production also has shown a drastic reduction.[2] The worldwide change in taste from veal to beef has caused a decline in the availability of calfskins for tanning. Calf leather production has declined from 9 million skins in 1957 to less than 1.5 million in 1974.[2]

Other types of skins or hides processed in the United States on a very limited basis include deer, elk, moose, antelope, rabbit, horse, and shark. Cattlehides, however, constitute an ever increasing percentage of the raw materials for tanning in this country. Currently, nearly 90 percent of all leather tanned is cattlehide leather.[2]

Development of Substitute Materials for Leather. The development of a synthetic substitute for one type of leather has caused a dramatic decrease in its production. Before the introduction of synthetics immediately after World War II, over 80 percent of all shoes had leather soles. By 1974, only 14 percent of the shoes produced in the United States had leather soles, the remainder using synthetic materials. This caused a corresponding decline in the production of vegetable tanned leather. In 1957, over 5 million hides were vegetable tanned for the production of shoe soles.[2] In 1974, only slightly over 2 million were vegetable tanned.[2]

Competitive Economic Status of the Industry. In spite of the fact that the United States has a plentiful supply of cattlehides, American tanners have not been able to take full advantage of this raw material. The development of shoe and other leather consuming industries in countries with low labor costs and government subsidies to their tanning industries has put American tanners at an economic disadvantage and has lead to a decline in this industry in the United States. Consequently, there has been a decline in leather demand by consuming industries in the United States. A corresponding increase in the demand for American hides, i.e., not tanned, has developed in other countries to supply their tanning industries. In 1974, the United States exported more than half of the 38 million cattlehides produced.[2]

Economic and Technical Changes. In the past few years, there has been a tendency to complete part of the leather tanning operations near the source of the hides, i.e., near the meatpacking activity, to reduce transportation expenses. This has given rise to the development of two new types of tanneries--called, for the purpose of this study, the beamhouse/tanhouse facility and the retan/finisher. Essentially, these are the operations conducted in a complete chrome tannery with the processing of the hides through the tanning operation carried on in the beamhouse/tanhouse facility and the processes from retain through leather finishing conducted by the retan/finisher. The beamhouse/tanhouse facility receives and processes cured or fresh hides (currently the trend is toward more fresh hides) through the beaming and tanning operations. Following chrome tanning, the now blue hides are shipped to the retan/finisher where the retanning and finishing processes are completed. Some tanneries have split their operations into two physically separated locations, and there are some firms which specialize in one-half or the other of this process. In 1974, approximately 10 percent of the hides tanned in the United States passed through this two-step process. It is estimated that this trend will continue.[2]

Environmental Considerations. Tighter restrictions regarding wastewater discharge from tanneries either directly to navigable waters or into municipal sewer systems may be influencing some relocations and changes in the industry. The development of the beamhouse/tanhouse facility and retan/finisher is partly due to these considerations. Older complete chrome tanneries located in the New England States often do not have the land available to construct pretreatment facilities necessary to remove the significant waste load generated by their beamhouse operations, thus the beamhouse and tanhouse could be physically moved to a location nearer to the source of hides. These locations are also more readily able to absorb the waste effluent from these operations, i.e., they have adequate wastewater treatment capacity or on-site evaporative disposal can be practiced. Research is underway to change operations and processes in order to reduce water consumption and wastewater generation.

Trends. The foregoing description of industry trends gives an indication as to the future developments that can be expected in the leather tanning and finishing industry. It can be predicted that changes will take place gradually in response to the following factors:

- Changes in the character and quantity of raw material supplied will lead to increased production of leather made from cattlehides in the United States.
- The development of newer substitute materials for leather will require experimentation and adapation within the tanning industry in order to obtain leather of different properties in order to adequately respond to the requirements of changing markets, i.e., the tanning industry will have to innovate in order to maintain and solidify its share of the market for similar materials.
- Economic and technical changes as well as the reaction to environmental considerations will result in a continued trend to relocation of facilities close to the source of cattlehide supply. This will lead to a gradual growth in importance of those operations having a beamhouse/tanhouse facility in one location and a retan/finisher in another.

2.2 Approaches to Characterizing Tanneries

2.2.1 Census of Manufactures. The Bureau of the Census classified the leather tanning and finishing industry (SIC 3111) into three types of establishments[1]:

- Regular tanneries--establishments which perform all or a part of the usual manufacturing functions within one organization.
- Converters--handlers or managers of hides being processed into leather. Converters may own the material in question but do not perform manufacturing functions which are contracted in whole or part to contract tanneries.
- Contract tanneries--processors of materials owned by another party, e.g., a converter. Contract tanners may provide all manufacturing processes or only selected steps in the processing chain, e.g., contract finishing operations. The latter situation is the most common.

It should be noted that the SIC classifications are not mutually exclusive. Some firms in the industry act in one, two, or all three of the above classifications. The Bureau of the Census classified plants according to the category in which the highest amount of wage and salary payments are made.

2.2.2 Production. The Tanners' Council uses a statistical unit called an equivalent hide to convert all types of raw material used for leather into a common unit of measure. This device allows the classification of all plants by size regardless of whether cattlehide, sheepskin, pigskin, or other raw material is processed. An equivalent hide is equal to a surface area measurement of 3.7 m^2 (40 ft^2). This unit of measurement was selected because most hides tanned in the United States are cattlehides and the average size of a cattlehide is approximately 3.7 m^2 (40 ft^2). Using production measured in equivalent hides, the Tanners' Council has divided the industry in the following manner:

Size category	Production in equivalent hides per day	No. of plants	Percent of plants in the industry
X-S (extra small)	200 or less	67	22
S (small)	201 to 600	114	37
M (medium)	601 to 1,200	60	21
L (large)	1,201 to 2,600	32	11
X-L (extra large)	2,600 or more	25	9

The distribution by state and EPA region using the above production size categories is shown in Table 9. It can be seen from this table that most of the extra small and small tanneries are located in the historical tanning areas of the New England and Middle Atlantic States (EPA Regions I and II). The large and extra large plants are located in the Midwest (EPA Regions V and VII) and Far West (EPA Region IX), as well as in the New England and Middle Atlantic States (EPA Regions I and II), and are near the source of cattlehides.

2.2.3 Tanning Process. Essentially all of the leather in the United States is produced by tanning with trivalent chromium (Cr^{+3}) or with extracts from the bark of certain trees. These processes are commonly referred to as chrome and vegetable tanning, respectively. Approximately 87 percent of the 20.2 million equivalent hides tanned in this country in 1974 were processed using chrome tanning.[2] Essentially all of the remaining 2.6 million equivalent hides were vegetable tanned. Insignificantly small numbers of equivalent hides were tanned for special purposes using alum, zirconium, or other tanning materials.[2]

Table 10 indicates the distribution of tanneries by the type of tanning process employed. The chrome tanneries make up 93 percent of the total number of tanneries. It should be noted that the vegetable tanneries are often located in sparsely populated Middle Atlantic (EPA Region III) and Southern States (EPA Region IV) and, within those states, they are often found in rural areas near the former source of the barks required in their processes. Currently, most vegetable tanneries in this country use imported bark extracts for their tanning and do not rely on local sources.[2]

2.2.4 Raw Material. As noted earlier, cattlehide is the most common raw material for the tanning industry. It is followed by sheepskin and pigskin, with only small numbers of other skins, e.g., calf, goat, reptile, etc., used as raw materials. Table 11 shows the distribution of tanneries by raw material. It can be seen that the cattlehide tanneries are widely dispersed as would be expected by their predominance in the industry. Pigskin tanneries are generally located in the Midwest near the source of the raw material. Sheepskin tanneries are primarily located in New England (EPA Region I), and New York (EPA Region II). Although a few domestic sheepskins are tanned, the majority are imported, primarily from New Zealand. Thus, the location of sheepskin tanneries near seaports is advantageous.

TABLE 9

DISTRIBUTION OF TANNERIES BY SIZE

Region	States Containing Tanneries	Total	XS	S	M	L	XL
X	Alaska	1	1				
IX	Arizona	1		1			
IX	California	14	3	3	3	2	3
VIII	Colorado	4	1	3			
III	Delaware	3		1	1	1	
IV	Florida	3	2	1			
IV	Georgia	1			1		
V	Illinois	11	2	4	2	2	1
V	Indiana	2		1	1		
VII	Iowa	2		1	1		
IV	Kentucky	3			1	2	
VI	Louisiana	1		1			
I	Maine	9		4			5
III	Maryland	1			1		
I	Massachusetts	79	24	33	15	5	2
V	Michigan	3				1	2
V	Minnesota	4		2		1	1
VII	Missouri	3		2		1	
VII	Nebraska	1		1			
I	New Hampshire	14	1	5	4	4	
II	New Jersey	25	7	11	6		1
II	New York	46	19	16	7	3	1
IV	North Carolina	3	1	1	1		
V	Ohio	4		4			
X	Oregon	4	3	1			
III	Pennsylvania	14	1	5	2	3	3
IV	Tennessee	9		3	2	2	2
VI	Texas	4		4			
VIII	Utah	1		1			
I	Vermont	1				1	
III	Virginia	2		1	1		
I	Washington	2	2				
III	West Virginia	2				1	1
V	Wisconsin	21		4	11	3	3
Total		298	67	114	60	32	25
Region I		103	25	42	19	10	7
II		71	26	27	13	3	2
III		22	1	7	5	5	4
IV		19	3	5	5	4	2
V		45	2	15	14	7	7
VI		5		5			
VII		6		4	1	1	
VIII		5	1	4			
IX		15	3	4	3	2	3
X		7	6	1			

Source: Tanners' Council of America

XS (extra small)--200 or less.
S (small) --201 to 600.
M (medium) --601 to 1,200.
L (large) --1,201 to 2,600.
XL (extra large)--2,600 or more.

TABLE 10

DISTRIBUTION OF TANNERIES BY TANNING PROCESS

Region	States Containing Tanneries	Total	Chrome	Vegetable
X	Alaska	1	1	
IX	Arizona	1	1	
IX	California	14	14	
VIII	Colorado	4	4	
III	Delaware	3	3	
IV	Florida	3	3	
IV	Georgia	1		1
V	Illinois	11	11	
V	Indiana	2		2
VII	Iowa	2	2	
IV	Kentucky	3		3
VI	Louisiana	1	1	
I	Maine	9	9	
III	Maryland	1		1
I	Massachusetts	79	79	
V	Michigan	3	3	
V	Minnesota	4	4	
VII	Missouri	3	2	1
VII	Nebraska	1	1	
I	New Hampshire	14	14	
II	New Jersey	25	25	
II	New York	46	46	
IV	North Carolina	3	1	2
V	Ohio	4	4	
X	Oregon	4	3	1
III	Pennsylvania	14	11	3
IV	Tennessee	9	7	2
VI	Texas	4	3	1
VIII	Utah	1	1	
I	Vermont	1	1	
III	Virginia	2	1	1
X	Washington	2	2	
III	West Virginia	2		2
V	Wisconsin	21	21	
Total		298	278	20
Region I		103	103	0
II		71	71	0
III		22	15	7
IV		19	11	8
V		45	43	2
VI		5	4	1
VII		6	5	1
VIII		5	5	0
IX		15	15	0
X		7	6	1

Source: Tanners' Council of America

TABLE 11

DISTRIBUTION OF TANNERIES BY RAW MATERIAL

Region	States Containing Tanneries	Total	Cattle hide	Calf skin	Sheep skin	Pig* skin	Other**
X	**Alaska**	1					1
IX	Arizona	1	1				
IX	California	14	11	1	1		1
VIII	Colorado	4	1				3
III	Delaware	3	3				
IV	Florida	3	1		2		
IV	Georgia	1	1				
V	Illinois	11	8		1		2
V	Indiana	7	2				
VII	Iowa	2	1		1		
IV	Kentucky	3	3				
VI	Louisiana	1					1
I	Maine	9	5		4		
III	Maryland	1	1				
I	Massachusetts	79	42	1	20		16
V	Michigan	3	2			1	
V	Minnesota	4	2		1		1
VII	Missouri	3	3				
VII	Nebraska	1	1				
I	New Hampshire	14	11		1		2
II	New Jersey	25	15		3		7
II	New York	46	11		22		13
IV	North Carolina	3	3				
V	Ohio	4	4				
X	Oregon	4	3				1
III	Pennsylvania	14	11		3		
IV	Tennessee	9	5				4
VI	Texas	4	3		1		
VIII	Utah	1	1				
I	Vermont	1	1				
III	Virginia	2	1				
X	Washington	2					2
III	West Virginia	2	2				
V	Wisconsin	21	12	1	2		6
Total		298	171	3	62	1	61
Region	I	103	59	1	25		19
	II	71	26		25		20
	III	22	18		3		
	IV	19	13		2		4
	V	45	30	1	4	1	9
	VI	5	3		1		1
	VII	6	5		1		
	VIII	5	2				3
	IX	15	12	1	1		1
	X	7	3				4

Source: Tanners' Council of America

* Although only one tannery in the country uses pigskin as its principal raw material, approximately 20 have experimented with pigskin and are developing processes and technologies for its use.

** Primarily specialized contract operations such as finishing.

2.2.5 Industry Categorization. None of the previously discussed approaches to characterization can be used to categorize the tanning industry for the purposes of this study. The wastestreams generated currently and in the future are functions of several factors including type of tanning, production operations (dictated to some degree by raw material and type of end product), and industry trends. After considering these factors, the following categories were developed:

- Complete chrome tannery.
- Vegetable tannery.
- Sheepskin tannery.
- Split tannery.
- Leather finisher
- Beamhouse/Tanhouse facility
- Retan/Finisher

During the first tannery visits and after discussions with industry officials, it became apparent that categories to be used in this project would not be the SIC subdivisions used by the Bureau of the Census.[1] Objections to categorization based upon SIC were noted in Section 2.2.1. Similarly, a strict delineation based solely upon tanning process, raw material used, product produced, size, or age of the tannery was not appropriate since none of these criteria adequately separated the industry into categories useful in determining and projecting waste characteristics and quantities. Therefore, the qualitative and quantitative differences among the wastestreams generated in the various types of tanneries served as the bases for characterizing the industry's wastes.

The first category developed was based upon the type of tanning agent, chrome or vegetable. The chrome tanneries and specialty operations were then further subdivided. It was found that cattlehide and pigskin tanneries produced similar types of solid wastes and also had similar waste generation factors, i.e., kg of waste produced per 1000 equivalent hides. Chrome sheepskin tanneries were notably different. Since most sheepskins are imported partially processed, little beaming is required. Additionally, the practice of fleshing after tanning produces a unique wastestream--chrome fleshings. Thus, based upon raw material and subsequent wastestream generation, two additional categories evolved--the complete chrome tannery (including cattlehide and pigskin) and the sheepskin tannery.

Another type of operation yielding considerably different waste quantities than the complete chrome tannery is the split tannery. In these operations, the chrome tanned split is trimmed, often resplit, and trimmed again before going through the retan, color, and fatliquor cycle. The sequence of trimming, splitting, and trimming yields higher waste generation factors for trimmings and shavings than is found in the complete chrome tannery. Another difference between the complete chrome operation and the split tannery is that the split tannery does essentially no finishing. Thus, there is no finishing residue requiring land disposal. Therefore, the split tannery was considered a separate category.

Contract leather finishers make up the largest segment of the contract operations conducted in the tanning industry. Their operations are similar to the finishing procedures used in complete chrome tanneries; however, some unique operations are included for specialty leathers. Since the finishers have no actual tanning operations, they were designated a separate category.

Vegetable tanneries are notably different in their processing steps and resultant solid wastestreams. The absence of chromium and other heavy metals lead to the presumption, later supported by analytical evidence, that vegetable tanneries produced no potentially hazardous wastes destined for land disposal.

Industry trends were also considered in the development of the categories for this project. The trend most influencing the types and quantities of solid waste produced in tanneries is the development of the beamhouse/tanhouse facility and retan/finisher. As noted earlier, these operations evolve from the separation of the classical complete chrome tannery into two segments. In the beamhouse/tanhouse facility, the hide is received and processed through the tanning operation. It is then transferred to the retan/finisher where processing continues, beginning with the retan, color, and fatliquor cycle, and ending with the finishing, measuring, and packaging of the leather. Only a small number of beamhouse/tanhouse operations currently produce "blue stock," or chrome tanned leather which has not yet been retanned and finished. However, a number of tanneries are investigating the possibility of establishing their own remote beaming and tanning operations. Several complete chrome tanneries have experimented, with varying degrees of success and acceptability, with using blue stock purchased from a beamhouse/tanhouse facility. The trend for the establishment of these two types of operations was taken into account for purposes of projecting waste quantities in 1977 and 1983.

These seven categories were developed to provide as accurately as possible a picture of the solid waste generated in the leather tanning and finishing industry. They include as much of the industry as possible and yet minimize the number of categories. In addition, the categories were designed to account for production trends in order to project the quantities of waste generated in 1977 and 1983.

Table 12 lists the number of establishments in each category by state and EPA Region. As shown, all types of tanneries, except beamhouse/tanhouse facilities and vegetable tanneries, are located primarily in EPA Regions I, II, and V. Vegetable tanneries are located primarily in EPA Regions III and IV, and beamhouse/tanhouse facilities are distributed quite evenly among EPA Regions V through IX.

TABLE 12

DISTRIBUTION OF TANNERIES BY CATEGORY

Region	States Containing Tanneries	Total	Complete Chrome	Vege-table	Split	Beamhouse/ Tanhouse	Retan/ Finish	Leather Finish	Sheep skin
X	Alaska	1	1						
IX	Arizona	1				1			
IX	California	14	9		1	1	2	1	
VIII	Colorado	4	3			1			
III	Delaware	3	1					2	
IV	Florida	3	1						2
IV	Georgia	1		1					
V	Illinois	11	8	1	1			1	
V	Indiana	2		2					
VII	Iowa	2				1			1
IV	Kentucky	3		3					
VI	Louisiana	1	1						
I	Maine	9	3				1	1	4
III	Maryland	1		1					
I	Massachusetts	79	15		14		7	29	14
V	Michigan	3	3						
V	Minnesota	4	2			1		1	
VII	Missouri	3	1	1		1			
VII	Nebraska	1	1						
I	New Hampshire	14	9		1		1	1	2
II	New Jersey	25	4			1	3	16	1
II	New York	46	15		2		6	10	13
IV	North Carolina	3		2				1	
V	Ohio	4	1					3	
X	Oregon	4	3	1					
III	Pennsylvania	14	5	3			3		3
IV	Tennessee	9	5	2			1	1	
VI	Texas	4		1		2			1
VIII	Utah	1	1						
I	Vermont	1							1
III	Virginia	2	1	1					
X	Washington	2	2						
III	West Virginia	2		2					
V	Wisconsin	21	12		5	1	1	1	1
Total		298	107	21	24	10	25	68	43
Region I		103	27		15		9	31	21
II		71	19		2	1	9	26	14
III		22	7	7			3	2	3
IV		19	6	8			1	2	2
V		45	26	3	6	2	1	6	1
VI		5	1	1		2			1
VII		6	2	1		2			1
VIII		5	4			1			
IX		15	9		1	2	2	1	
X		7	6	1					

Source: Tanners' Council of America

SECTION 3.0

WASTE CHARACTERIZATION

3.1 Development of Typical Plants

In this section, production processes and the types and quantities of process solid waste resulting from each process are described for each category of the industry. A definition of potentially hazardous waste is presented, and the types and quantities of process solid waste currently generated which are potentially hazardous and are destined for land disposal are identified. Projections are made for the quantities of solid waste anticipated to be produced in 1977 and 1983. Waste quantity projections are based upon estimates of changes in industry production, the effects of air and water pollution control regulations, and various in-plant process changes. In addition to waste quantities, the quantities of hazardous constituents within the potentially hazardous wastestreams are presented for 1974, 1977, and 1983.

In order to present the available information in a concise and understandable manner, "typical" plants have been identified for the major categories of tanneries. Mass balance diagrams for these typical plants reflect general operations as well as input and output of materials per unit of production. It must be emphasized that tanneries, even within the categories described in this section, vary widely in size and operation, e.g., 100-fold differences. All typical plants are located in urban areas, predominantly in the East or Midwest (EPA Regions I, II, III, IV) and utilize contract services for solid waste hauling and disposal. All of the typical plants are 50 years old with the exception of the beamhouse/tanhouse facility which is 15 years old.

3.1.1 Approach to Waste Characterization. Process solid waste is defined, for this study, as solids, sludges, and other waste generated directly as a result of the manufacturing processes in the industry and normally disposed to the land. These wastes primarily consist of small pieces of leather in various stages of processing or sludges collected from sewer sumps or wastewater treatment facilities. Other items in the process wastestream include:

- Salt and string from the hide receiving areas.
- Empty bags and drums from chemical mixing areas.
- Finishing residues (scrapings and sludges) from finishing department.
- General plant floor sweepings.

Not included as process solid waste was:

- Office and lunchroom waste.
- Paper towels, etc. from restrooms.

In order to determine the types, quantities, and characteristics of the process solid waste generated by the tanning industry, 41 tanneries were visited. During the tannery visits, the following types of information were obtained:

- Production.
- Types and quantities of chemicals used.
- Types and quantites of solid waste generated.
- Analytical wastewater information, particularly quantities discharged and solids content.
- Information concerning air pollution control devices and solids generated.
- By-product sales data.

A total of 156 waste samples were collected from 28 of the 41 tanneries visited. These samples were subsequently analyzed for a variety of hazardous organic and inorganic constituents. An outline of the procedures for collection, shipment, and analysis of the samples is included in Appendix B.

Utilizing the data collected at the tanneries and the laboratory analytical results, a matrix was developed for each major type of wastestream found in tanneries. Figure 4 is an excerpt from one of the matrices. Examination of the matrices showed clearly where variations in the composition of a particular waste occurred as a result of the type of tannery in which it was generated. Based upon this and a consideration of production trends in the industry, the seven categories of tanneries were identified. As an example of the use of the matrix, the toxic, heavy metal content in wastes from vegetable tanneries was at a level below the selected threshold. This was the only group of tanneries for which this was true and thus led to the establishment of vegetable tanneries as a separate category.

In order to summarize the operations performed at each of these seven categories of tanneries, mass balance diagrams were developed and are included in Sections 3.3 through 3.9. Each diagram is divided into three sections vertically. General processing steps are shown down the center. The materials added are shown on the left and the finished leather, by-products, and waste are shown at the bottom and right. The figures shown are the kg of each constituent (on a dry weight basis) per 1000 equivalent hides.

FIGURE 4

EXAMPLE OF WASTESTREAM MATRIX

		Wastewater Treatment Residues			
Plant and Sample No.		W-W	X-X	Y-Y	Z-Z*
Process		Vegetable	Vegetable	Chrome Cattle	Chrome Cattle
Production (hides/day)		1,300	770	750	2,000
Waste Quantity (lb/day)	wet dry	33,000 380	13,500 445	1,675 345	8,200 5,040
(yd^3/day)		18	7.4	0.9	4.5
Waste Generation (lb/1000 hides)	wet dry	25,400 292	17,530 580	2,333 459	4,100 2,520
Moisture (%)		98.85	96.74	79.42	38.46
Constituents	wet dry				
Cr	(ppm)	0.33 29	5.7 170	1,900 9,800	11,000 18,000
	(kg/1000 hides)	0.00381	0.045	1.926	20.5
Cu		0.12 11	4.8 150	3.3 16	8,400 13,300
		0.00138	0.038	0.00353	15.6
Pb		1.4 120	1.8 55	27 130	240 380
		0.0161	0.014	0.0274	0.447

Source: SCS Engineers

* Sample taken after dewatering by centrifuge.

Utilizing the above data, information regarding industry production and trends provided by the Tanners' Council, and a criteria developed for defining potentially hazardous waste (discussed in Section 3.2), the quantities of total process solid waste and potentially hazardous solid waste were estimated for 1974, 1977, and 1983. Waste generation factors were developed for each wastestream and hazardous constituent for each category of tannery. These factors are in kg per 1000 equivalent hides and take into account process changes which will vary the generation rates. Production for each category of tannery in each state during 1974 was provided by the Tanners' Council and was projected for 1977 and 1983.

Each of the seven tannery categories is discussed in turn, in Section 3.3 through 3.9. The major points included in each section are:

- Plant operations (including the mass balance diagram).
- Discussion of sources and quantities of potentially hazardous and non-hazardous waste.
- Factors affecting future solid waste generation.
- Summary tables of waste quantities (both total process and potentially hazardous solid waste).

3.2 Determination of Potentially Hazardous Waste

3.2.1 Criteria. "Potentially hazardous waste" is defined as waste or combinations of waste which pose a substantial present or potential hazard to human health or living organisms because such waste is lethal, non-degradable, or persistent in nature; may be biologically magnified; or otherwise cause or tend to cause detrimental cumulative effects.[3] Waste is classified as potentially hazardous due to the presence of hazardous constituents at a concentration level above a selected threshold. Thus, the constituents of the waste, e.g., specific, toxic, heavy metals, are referred to as hazardous. These hazardous constituents make a waste potentially hazardous if they occur in sufficient concentration.

Potentially hazardous waste contain constituents which are:

- Radioactive.
- Infectious.
- Explosive.
- Flammable.
- Irritants or strong sensitizers.
- Corrosive.
- Toxic.

Of the above listed characteristics which may make a wastestream potentially hazardous, toxicity is the most significant to this study, and at the same time the most difficult to define. The toxicity of a substance is largely dependent upon the concentration levels under various environmental conditions. An assessment of the degree of hazard introduced by the disposal of waste containing naturally occurring constituents is not a simple straight line or exponentially increasing function starting from zero, as it may be for many synthesized compounds. This results from the fact that life forms have evolved in the presence of, and acclimated to, these naturally occurring elements and their compounds at the naturally occurring background concentration levels in various environmental media. As a result, many of the substances of particular concern in this study, primarily heavy metals, are prerequisites to life in trace quantities, but are toxic at higher concentrations.

The uncertainty and confusion about what concentration levels are hazardous arises because:

- In the complete absence of certain elements, life cannot exist.
- There is a vaguely defined intermediate concentration range in which these substances are essential and/or can be tolerated.
- There is a higher level above which chronic and acute toxicity may result.

A clear definition of the threshold toxicity level of a particular element or compound is further complicated by the fact that these threshold concentration levels are:

- Highly variable from one species to another.
- Extremely dependent upon the medium or environment in which they live, and on the medium of exposure (water, soil, or air).
- Altered by synergistic or antagonistic reactions in a particular environment.
- Affected by such factors as temperature, pH, and the presence of other ionic species.

Furthermore, the form in which an element occurs, e.g., as a mineral, as a pure element, or as a water soluble salt or oxide, strongly influences its toxicity to various organisms. Previous studies and lists of hazardous materials promulgated by Federal agencies served as the basis for determining whether a given wastestream constituent should be considered hazardous.

3.2.2 Definition of Potentially Hazardous Waste.

Definitive information concerning the environmental fate and subsequent effects of the hazardous constituents in the solid waste generated by the leather tanning and finishing industry is not available. Scientific studies of the environmental fate of tannery solid waste following land disposal have not been conducted, and in many instances the chemical structure of tannery solid waste is not well understood. As a result, it was necessary to select a recognized, reasonable reference for identifying the concentration level at which a hazardous constituent should be present in order to consider a waste as potentially hazardous. As a guide as to what constitutes potentially hazardous concentration levels in waste destined for land disposal, the geometric means of the background concentration levels of these constituents in soils in the United States were used as this reference.[4] Table 13 lists these values for heavy metals.

The geometric mean concentration in U.S. soils was selected because the study was confined to and focused on land disposal of tannery waste in this country. As noted earlier, little is known of the environmental fate of tannery waste following land disposal. The geometric mean soil concentration gives the best indication of the concentration of hazardous constituents in the soil environment which plant and animal life can surely tolerate. However, increases in the concentration of hazardous constituents above these levels may result in an adverse impact on the environment. Consequently, tannery waste with hazardous constituent concentrations above the corresponding mean soil concentration should be considered potentially hazardous until such time as studies are conducted which indiate a different value is environmentally sound.

During this study, waste samples were collected and analyzed to determine the concentrations of potentially hazardous constituents in all types of tannery solid waste. The results of these analyses showed that copper, zinc, lead, and trivalent chromium were present in various types of solid waste at concentrations exceeding the geometric mean background levels present in U.S. soils. The information available in the relevant literature and previously contracted studies indicates that copper, lead, zinc, and trivalent chromium are moderately to highly toxic materials.[7,11,12]

Samples were analyzed for other heavy metals (mercury, arsenic, zirconium, beryllium, cadmium, and selenium) and other hazardous constituents (pesticides and phenols), but none were found in significant quantities.

Eight types of solid waste from tanneries producing chrome tanned leather were identified as being potentially hazardous due to their heavy metal content. Additionally,

TABLE 13

GEOMETRIC MEAN COMPOSITIONS, AND GEOMETRIC DEVIATIONS, OF SAMPLES OF SOILS AND OTHER SURFICIAL MATERIALS IN THE CONTERMINOUS UNITED STATES

(GEOMETRIC MEANS REPORTED IN PARTS PER MILLION)

	The conterminous United States n* ≃ 863		Western United States (west of 97th meridian) n* ≃ 492		Eastern United States (east of 97th meridian) n* ≃ 371	
Element	Geometric mean	Geometric deviation	Geometric mean	Geometric deviation	Geometric mean	Geometric deviation
Al	45,000	2.41	54,000	2.02	33,000	2.70
B	26	2.05	22	2.09	32	1.92
Ba	430	2.06	560	1.80	300	2.19
Be	0.6	2.49	0.6	2.47	0.6	2.53
Ca	8,800	3.92	18,000	2.93	3,200	2.87
Co	7	2.21	8	2.01	7	2.55
Cr	37	2.32	38	2.16	36	2.52
Cu	18	2.28	21	2.00	14	2.54
Fe	18,000	2.30	20,000	1.90	15,000	2.76
Ga	14	2.11	18	1.71	10	2.53
K	12,000	2.71	17,000	1.60	7,400	3.56
Mg	4,700	3.19	7,800	2.21	2,300	3.39
Mn	340	2.70	389	1.94	285	3.65
Na	4,000	4.11	10,200	1.98	2,600	4.11
Ni	14	2.26	16	2.03	13	2.60
P	250	2.74	320	2.33	180	3.03
Pb	16	1.96	18	1.93	14	1.96
Ti	2,500	1.87	2,100	1.82	3,000	1.84
V	56	2.16	66	1.91	46	2.41
Zn	44	1.86	51	1.78	36	1.89
Zr	200	1.90	170	1.78	250	1.95

Source: Reference 21

* n = Number of samples.

the finishing residue wastestream (already categorized as potentially hazardous because of its metal content) also contains flammable solvents and is thus considered potentially hazardous on two counts. The wastestreams categorized as potentially hazardous are shown in Table 14. Also listed are the concentrations (mean and range) on a wet weight basis. This is compared to the geometric mean concentration in U.S. soils. The mean concentration of trivalent chromium in all waste was well above the soil concentration, ranging from 59 to 457 times the mean concentration in U.S. soils.

3.2.3 Discussions of Hazardous Constituents. Information on the toxicity of copper, lead, zinc, and trivalent chromium is summarized in Table 15. As the table indicates, all of these metals have been shown to be moderately toxic (LD_{50} from 500 to 5,000 mg/kg) or very toxic (LD_{50} from 50 to 500 mg/kg), as a result of tests on experimental animals.

Although the environmental effects of lead, zinc, and copper are not completely understood, the phototoxicity of zinc and copper to agricultural crops, the toxicity of lead to man, and the toxicity of all three elements to various aquatic organisms, is well established. The toxicological information on chromium, however, is conflicting. Of these four elements, only lead is thought to have detrimental effects on human health in low to moderate concentrations, and correspondingly only lead has a mandatory drinking water standard. Zinc and copper have recommended limits. Hexavalent chromium has a mandatory limit, but there is no stated limit for trivalent chromium.[13]

Chromium. Chromium and its compounds take on unusual importance in this study because of their prevalent use in the tanning process. Chromium occurs often, and in high concentrations, in both wastewater and solid wastestreams. The chrome tanning process employs basic trivalent chromium, chromic sulfate (empirical formual $Cr(OH)SO_4$). However, some tanneries purchase sodium dichromate (hexavalent chromium) as a raw material and reduce it to trivalent chromium preparatory to usage. In its hexavalent state (as chromic oxide, chromate, or dichromate), chromium is a strong oxidizing agent which reacts readily with organic matter in acidic solution. Complexes in which hexavalent chromium would be stabilized against reduction by organic matter are now known. All biologic interactions with chromate should result in reduction to the trivalent form and later coordination to organic molecules. This has been widely demonstrated by the effect of chromate on skin, the interaction of dichromate or chromates with nucleic acids and with the reaction and fate of chromate injected into experimental animals.[9]

TABLE 14

POTENTIALLY HAZARDOUS TANNERY WASTES

Waste Stream	No. of Samples	Hazardous Constituent*	Analytical Results		Geometric Mean Concentration in U.S. Soils (dry weight-mg/kg)
			Mean Concentration (wet weight-mg/kg)	Concentration Range** (wet weight-mg/kg)	
Chrome (blue) trimmings & shavings	10	Cr^{+3}	7,600	2,200-21,000	37
Chrome fleshings	1	Cr^{+3}	4,000	----	37
Unfinished chrome leather trim	9	Cr^{+3}	16,900	4,600-37,000	37
		Cu	90	2.3-468	18
		Pb	120	2.5-476	16
		Zn	60	9.1-156	44
Buffing dust	12	Cr^{+3}	5,700	19-22,000	37
		Cu	960	29-1,900	18
		Pb	150	2-924	16
		Zn	160	----	44
Finishing residues	16	Cr^{+3}	3,500	0.45-12,000	37
		Cu	40	0.35-20[illegible]	18
		Pb	8,400	2.5-69,200	16
		Zn	150	14-876	44
Finished leather trim	4	Cr^{+3}	14,800	1,600-41,000	37
		Pb	1,000	100-3,300	16
Sewer screenings	17	Cr^{+3}	2,200	0.27-14,000	37
		Pb	30	2-110	16
		Zn	60	35-128	44
Wastewater treatment residues (sludges)	27	Cr^{+3}	3,700	0.33-19,400	37
		Cu	370	0.12-8,400	18
		Pb	60	0.75-240	16
		Zn	50	1.2-147	44

Source: Laboratory analytical results and Reference 21

Note : Since tannery wastes are land disposed in a wet condition, i.e., containing moisture, reporting constituent concentrations on a wet weight basis realistically portrays the waste streams' chemical characteristics with respect to hazardous constituents. Constituent concentrations in U.S. soils were not available on a wet weight basis. Geometric mean values on a wet weight basis would be slightly less than those reported above. Thus the method of reporting the concentrations (wet or dry basis) does not impact on the designation of a waste stream as non-hazardous or potentially hazardous.

* For which analyses were made.

** Range not shown when only one sample was analyzed for the constituent.

TABLE 15

SUMMARY OF TOXICITY-RELATED INFORMATION FOR CHROMIUM (III), LEAD, ZINC, AND COPPER

	Chromium (III)	Lead	Zinc	Copper
LD_{50}	$Cr_2(SO_4)_3$: 500 to 5,000 mg/kg	Salts: 50 - 500 mg/kg	Salts: 50 - 500 mg/kg	Salts: 50 - 500 mg/kg
TL_m	1.2 - 40 mg/1. Various species under various conditions.	0.1 - 6.3 mg/1. Various species of fish, 24 - 96 hours.	0.1 - 13 mg/1. Various species of fish 24 - 96 hours.	0.02 - 3.0 mg/1. Various fish under various conditions.
USPHS Drinking Water Standard	None for Cr (III); 0.05 mg/1 for Cr(VI)- mandatory	0.05 mg/1 - mandatory	5.0 mg/1 (recommended)	1.0 mg/1 (recommended)

Source: References 15, 19

This organic reduction of any residual hexavalent chromium to the trivalent form during the tanning process has been confirmed by analytical testing of a cross-section of chromium containing wastestreams selected at random as a part of this study. Eighteen such determinations were made on the following samples:

Waste type	No. of samples
Trimmings and shavings	3
Buffing dust	2
Finishing residues	3
Screenings	2
Wastewater treatment sludge	8

Hexavalent chromium concentrations in all 18 samples analyzed were below the detection limit (0.05 mg/l). Based on this, there is strong reason to believe that even accidental spills of hexavalent chromium would be reduced before leaving a tannery if conveyed through a portion of the sewer system and/or treatment process. One instance of hexavalent chromium appearing in tannery waste has been reported.[14] However, this isolated report has not been confirmed. Thus, the only chromium compound of concern and interest in this study is trivalent chromium.

Trivalent chromium is far less toxic than hexavalent chromium based upon available information in the literature.[5,6,7] Since a large percentage of the chromium containing solid wastestreams are now being land disposed, the concentration ranges at which chromium impacts on plant and animal forms is of crucial importance to this study. Some information is available on the effects of chromium on plants which generally indicates that low concentrations of chromium appear to be beneficial, or possibly even essential, whereas higher concentrations may be toxic. The effects vary with species and with specific chromium compound. The effects on plant growth of adding chromium to the soil depend upon the amount of chromium naturally present in the soil. In some instances, crop yields have been improved by application of chromium to soils. The following examples have been excerpted from the literature:

- The addition of chromic sulfate ($Cr_2(SO_4)_3$) to soil at 600,000 mg/ha (0.54 lb/acre) improved the weight, size, and sugar content of grapes by 21, 18, and 23 percent, respectively, while increasing the yield by 205 to 245 kg/ha (183 to 219 lb/acre).[15]
- The application of a fertilizer containing 4,300 mg/kg chromium resulted in increased growth in flax grown on sand.[16]

- Addition of chromous acetate in concentrations of 500 mg/l or less had a beneficial effect on carrots, barley, lupines, and cucumbers.[17]
- Application of chromium (as the alum) at 40,000 mg/ha (0.036 lb/acre) to a soil containing extractable chromium at only 65 mg/kg increased the yield of potatoes from 32.7 to 46.5 tons per hectare (13.2 to 18.8 tons/acre).[18] Similar results were obtained for peas, carrots, and beets.[19,20]
- Applications of potassium dichromate at 30,000 and 100,000 mg/m^3 (0.03 lb/yd^3) of soil increased the yield of cucumbers.[21]
- Chromium at 1 mg/l in nutrient solution benefited lettuce slightly.[21]
- Chromium at 5 mg/kg increased the rate of nitrification.[21]

Conversely, a number of observations have been made of toxic effects of trivalent chromium as follows[9]:

Plant	Tolerated concentration (ppm)	Toxic concentration (ppm)	Chemical form
Orange seedlings	75	150	Chromium
Corn seedlings	.5	5	Chromic sulfate
Tomatoes, Oats, Kale, Potatoes	16 (yield reduced)	--	Chromium as Chromate
Oat Plants	5-10 (produced iron chlorosis)	15-50	Chromium (chromic or chromate)
Tobacco	--	5	Chromate
Corn	--	10	Chromate

In addition, toxicity has sometimes been associated with trivalent chromium in plant tissues. In fruits, vegetables, and grains concentrations from trace amounts to 14 mg/kg (dry tissue) were generally tolerated; but toxic effects appeared in corn with leaves containing 4 to 8 mg/kg and in oats with leaves containing 252 mg/kg. Tobacco grown in serpentine soil with an atypically high concentration of trivalent chromium showed toxic symptoms when the leaves contained 18 to 34 (dry weight) mg/kg, although no toxic effects were visible at 14 mg/kg. The roots showed signs of toxic effects at 375 to 400 mg/kg.[21]

Toxicity of trivalent chromium to various aquatic organisms has also been reported in the literature and is summarized in Table 16.[6,9] Conversely, recent attempts to repeat some of the earlier studies regarding the toxicity of trivalent chromium to sticklebacks and other fish have ended with the conclusion that pH and/or the solubilizing agents used were the cause of the reported toxicity.[8]

Since the predominant method of disposal of chromium containing tannery waste is land disposal, concern for the environmental impact of disposal centers on the propensity of a chromium containing waste to leach, its relative mobility, soil attenuation properties, and possible contamination of groundwater supplies.

Because the escape of chromium containing leachate into the groundwater or to a receiving water body is the major concern, the Tanners' Council of America conducted (as part of this study) leaching tests of various chromium containing solid waste. These tests, using distilled water, indicate that from 200 to 400 mg of trivalent chromium is released from 1 kg of trimmings and shavings in periods ranging from 24 to 72 hours.[2]

Other research has shown that chromium is relatively uneffected by most organic acids but is solubilized slowly by acetic acid.[9] Acetic acid is a major component of most anaerobic fermentation or digestion processes within landfills, comprising an estimated 30 to 60 percent of the total organic acids produced. These two studies suggest that trivalent chromium could ultimately be leached out of the waste material.

As the preceding paragraphs have indicated, the existing information on the toxicity of trivalent chromium to plants and aquatic organisms is contradictory in many instances. However, trivalent chromium could ultimately be leached from tannery waste, and since it is reported by some researchers as being toxic to various plants and aquatic organisms, trivalent chromium is considered to be a hazardous constituent of tannery solid waste.

3.3 Complete Chrome Tannery

3.3.1 Plant Operations. The basic processes used to produce chrome tanned and finished leather are shown in Figure 5. Brine cured, prefleshed cattlehides represent approximately 70 percent of the raw material of the tanning industry. The other 30 percent of the raw material utilized is fresh and salt cured cattlehides or pigskins.[2] As received, hides contain about 50 percent moisture. After receipt at the tannery, the hides are normally sided (cut in half down the backbone) to facilitate processing, and then soaked in water to return the natural moisture to the

TABLE 16

TRIVALENT CHROMIUM TOXICITY TO AQUATIC ORGANISMS

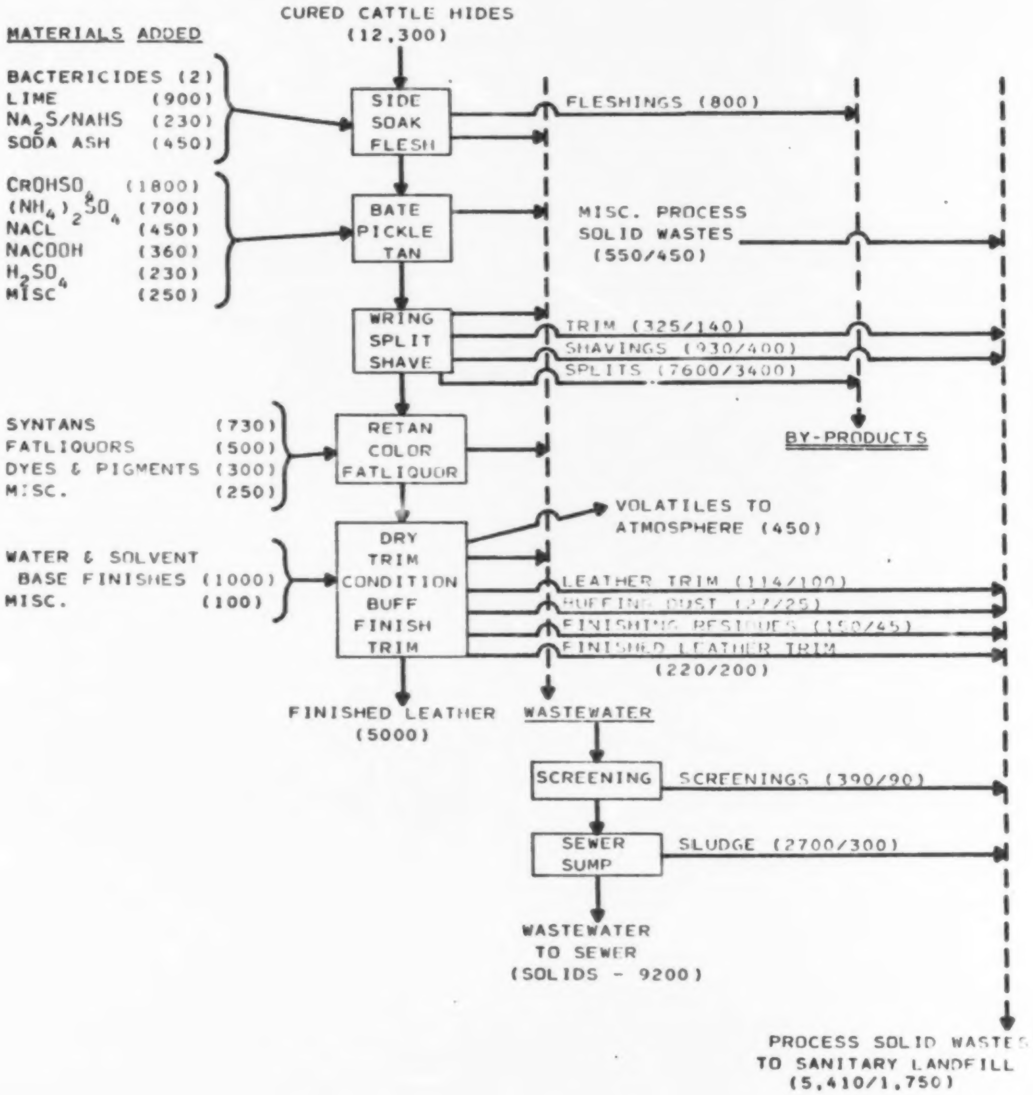
Concentration of trivalent chromium, mg/l	Compound Used	Organism	Remarks
1.2	$Cr_2(SO_4)_3$	Sticklebacks	Lethal limit
1.3	$Cr_2(SO_4)_3$	Sticklebacks	Survived only 1 wk
2.0	$Cr_2(SO_4)_3$	Sticklebacks	Survived only 2 days
2.4	$Cr_2(SO_4)_3$	Sticklebacks	Lethal limit
5.0	$Cr_2(SO_4)_3$	Sticklebacks	Survived only 1 day
5.2	$KCr(SO_4)_2$	Young eels	Survived an average of 18.7 hours
40	$Cr_2(SO_4)_3$	Minnows	Survived in distilled water only 6 hours
$\ll 1.2$	$CrCl_3$	Daphnia magna	25° C Lake Erie water
5	Cr (III)	Scenedesmus	Toxic threshold
37	Cr (III)	Microegma	Toxic threshold
42	Cr (III)	Daphnia	Toxic threshold
75	Cr (III)	Polycelisnigra (flatworm)	Toxic threshold in 48 hours of exposure
27	Cr (III)	Flathead minnows	96 hour LC_{50}
0.33	Cr (III)	Daphnia	Chronic. No effect level for reproduction

Source: References 6,9

FIGURE 5

PROCESS FLOW DIAGRAM
TYPICAL COMPLETE CHROME TANNERY

(all units are kg/1000 equivalent hides on a dry weight basis except solid wastes which are given on a wet/dry basis)



CURED CATTLE HIDES (12,300)
MATERIALS ADDED
BACTERICIDES (2)
LIME (900)
NA2S/NAHS (230)
SODA ASH (450)
SIDE SOAK FLESH
FLESHINGS (800)
CROHSO4 (1800)
(NH4)2SO4 (700)
NACL (450)
NACOOH (360)
H2SO4 (230)
MISC (250)
BATE PICKLE TAN
MISC. PROCESS SOLID WASTES (550/450)
WRING SPLIT SHAVE
TRIM (325/140)
SHAVINGS (930/400)
SPLITS (7600/3400)
BY-PRODUCTS
SYNTANS (730)
FATLIQUORS (500)
DYES & PIGMENTS (300)
MISC. (250)
RETAN COLOR FATLIQUOR
VOLATILES TO ATMOSPHERE (450)
WATER & SOLVENT BASE FINISHES (1000)
MISC. (100)
DRY TRIM CONDITION BUFF FINISH TRIM
LEATHER TRIM (114/100)
BUFFING DUST (27/25)
FINISHING RESIDUES (150/45)
FINISHED LEATHER TRIM (220/200)
FINISHED LEATHER (5000)
WASTEWATER
SCREENING
SCREENINGS (390/90)
SEWER SUMP
SLUDGE (2700/300)
WASTEWATER TO SEWER (SOLIDS - 9200)
PROCESS SOLID WASTES TO SANITARY LANDFILL (5,410/1,750)

hide fibers. Excess flesh and fatty substances which adhere to the hides are removed mechanically, and the hides are treated with lime and sodium sulfide to dissolve the hair. The hides are then treated with an enzyme in order to loosen the fiber structure ("bated"), pickled to prepare the hide fibers for penetration of the tanning substance, and then tanned with a solution of basic chromium sulfate $Cr(OH)SO_4$.

Following tanning, excess moisture is removed by wringing, and the hides are then split to obtain a uniform thickness, and shaved to obtain the exact thickness desired. The resulting blue trimmings and shavings contain about 60 percent moisture. Next, the hides are retanned with vegetable extracts or synthetic tanning agents (syntans) colored with a water soluble dye or pigment, and fatliquored (a process in which oils are added to the hides to impart the desired degree of flexibility). The hides are stretched on a metal frame, pasted on large plates, or hung on racks, and then dried in an oven or heated room. The resulting leather is trimmed to remove ragged edges, physically conditioned to soften the leather, and buffed to smooth the grain surface or the flesh side of the hides. At this point, the leather containing about 10 percent moisture may be sold, but is normally finished with a water or solvent-base preparation to improve wear, improve its water repellent characteristics, and/or alter its color. The finished leather (also with a 10 percent moisture content) is then trimmed and measured, and is ready for sale. A typical tannery in this category processed 260,000 equivalent hides in 1974.[2]

Figure 5 also indicates the basic production operations performed, the types and quantities of raw materials and products involved, and the types and quantities of waste products resulting from the production process.

3.3.2 Potentially Hazardous Solid Waste. Several kinds of solid waste is generated. The potentially hazardous wastestreams are discussed below.

Blue Trimmings and Shavings. Blue trimmings and shavings are generated when tanned hides are split and shaved to obtain a uniform thickness. Average generation rates are 325 (wet)/140 (dry) kg per 1000 equivalent hides for trimmings and 930 (wet)/400 (dry) kg per 1000 equivalent hides for shavings, which on a national basis, totals 19,500 (wet)/ 8,850 (dry) metric tons per year. The latter figures were calculated using production data supplied by the Tanners' Council of America. Samples were collected from the shaving machine and from fiber drums in the trimming department of six complete chrome tanneries. Analysis of these samples indicated that this type of solid waste has an average chromium concentration of 9,600 (wet)/22,300 (dry) mg/kg, with a range of 10,000 to 28,000 mg/kg on a dry weight basis.

Other naturally occurring hazardous constituents are present only at concentrations below their respective average background concentrations in soils, if at all. Synthetic substances were not detected in this wastestream.

Unfinished Leather Trim. Following drying and before finishing, the sides of leather are normally trimmed to remove ragged edges which would interfere with the finishing process. The average rate of generation of this waste material is 114 (wet/100 (dry) kg per 1000 equivalent hides, which on a national basis amounts to 1,900 (wet)/ 1,650 (dry) metric tons per year. Analysis of samples collected from the trimming departments of seven tanneries indicated the presence of the following hazardous constituents:

Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry	Concentration range (mg/kg) Dry
Chromium	15,000	17,000	3,600 - 42,000
Lead	110	130	3 - 530

Buffing Dust. Buffing dust is produced when the dried and trimmed leather is mechanically sanded to remove surface imperfections or improve the nap of the flesh side. A representative tannery in this category generates 27 (wet)/ 25 (dry) kg per 1000 equivalent hides, and all complete chrome tanneries generate a total of 443 (wet)/400 (dry) metric tons per year. Analysis of samples taken from the dry buffing dust collectors (cyclone collectors and bag houses) at seven plants showed the presence of the following hazardous constituents:

Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry	Concentration range (mg/kg) Dry
Chromium	20,000	22,000	1,200 - 60,000
Lead	71	77	44 - 120

Finishing Residues. Finishing residues are produced as a result of water-wash air pollution control devices on spray booths and from general cleaning of the finishing equipment. A representative complete chrome tannery generates 150 (wet)/ 45 (dry) kg per 1000 equivalent hides processed, which amounts to 2,460 (wet)/738 (dry) metric tons per year on a national basis. Analysis of samples taken from the finishing area in nine tanneries indicated the presence of the following hazardous constituents:

Constituent	Avg. concentration (mg//kg) Wet	Dry	Concentration range (mg/kg) Dry
Chromium	525	1,700	<4 - 5,200
Lead	1,100	3,600	<10 - 17,000
Zinc	105	340	Not detected 1,400

In addition, flammable organic solvents comprise approximately 10 percent of the wet weight of this waste. This amounts to 15 kg (wet) per 1000 equivalent hides processed or 246 (wet) metric tons per year nationally. These solvents also make this waste potentially hazardous.

Finished Leather Trim. The final operation performed before packaging the finished leather for shipment is trimming. A representative plant produces 220 (wet)/200 (dry) kg per 1000 equivalent hides processed, which on a national basis amounts to 3,610 (wet)/3,280 (dry) metric tons per year. Analyses of samples taken from the trimming and shipping department of three plants indicated the presence of the following hazardous constituents:

Constituent	Avg. concentration (mg/kg) Wet	Dry	Concentration range (mg/kg) Dry
Chromium	19,100	21,200	7,600 - 45,000
Lead	250	280	120 - 460

Wastewater Screenings. A representative complete chrome tannery screens its wastewater prior to discharge for further treatment. This process generates 390 (wet)/ 90 (dry) kg of solid waste per 1000 equivalent hides processed, which on a national basis amounts to 6,400 (wet)/1,480 (dry) metric tons per year. Samples were collected from the wastewater screens at seven complete chrome tanneries. An analysis of these samples indicates that the following constituents are present in potentially hazardous concentrations:

Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry	Concentration range (mg/kg) Dry
Chromium	965	4,200	5 - 14,000
Lead	40	176	43 - 190

Wastewater Treatment Sludges (from sewer sumps). A representative complete chrome tannery utilizes sewer sumps to remove solids from their wastewater prior to discharge, and generates 2,700 (wet)/300 (dry) kg of wastewater solids per 1000 equivalent hides processed, which amount to 34,100 (wet)/3,800 (dry) metric tons per year from all complete chrome tanneries in the Nation. Analyses of samples taken from sewer sumps at seven plants indicated that the following constituents are present in potentially hazardous concentrations:

Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry	Concentration range (mg/kg) Dry
Chromium	2,700	24,000	280 - 75,000
Copper	190	1,700	20 - 13,300
Lead	25	230	40 - 380

Waste Treatment Sludges (from primary and/or secondary treatment). A few aytpical complete chrome tanneries utilize primary pretreatment (with a rectangular or circular clarifier) prior to discharge to a municipal sewer. In a very few instances, primary treatment is followed by secondary treatment (activated sludge) prior to direct discharge.

Complete chrome tanneries with primary and/or secondary wastewater treatment and sludge dewatering remove an average of 10,000 (wet)/2,400 (dry) kg of wastewater sludge per 1000 equivalent hides processed, which on a national basis amounts to 34,000 (wet)/8,100 (dry) metric tons per year. The limited number of plants employing primary and/or secondary wastewater treatment, and variations (unquantified) among plants in the quantities of chemicals used, prevented the development of separate generation factors for plants utilizing primary treatment and those with both primary and secondary treatment. Analysis of samples of primary and/or secondary wastewater treatment sludge collected from the treatment systems at seven plants indicated that the following constituents are present in potentially hazardous concentrations:

Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry	Concentration range (mg/kg) Dry
Chromium	7,700	38,800	15,500 - 75,000
Copper	420	2,000	50 - 5,800
Lead	65	310	<10 - 800

Approximately 20 percent of the complete chrome tanneries employ primary and/or secondary treatment of their wastewater, and most of the remaining 80 percent of this category of the industry utilize sewer sumps to remove solids from their wastewater. As a result, a total of 68,100 (wet)/ 11,800 (dry) metric tons per year of sludge are currently being generated from these sources nationally.

3.3.3 Non-Hazardous Solid Waste.

Miscellaneous process solid waste is generated at a rate of 500 (wet)/ 450 (dry) kg per 1000 equivalent hides processed, which amounts to 8,400 (wet)/7,600 (dry) metric tons per year on a national basis. This waste is composed of empty fiber drums and paper bags, strings cut off the hides, and general plant floor sweepings, and they do not contain consitutents at potentially hazardous concentrations. Fleshings generated by nearly all chrome tanneries are sold; they were, therefore, not considered as a solid waste.

3.3.4 Factors Affecting Future Solid Waste Generation.

Air Pollution Control. Air pollution control devices are used to remove particulates produced by the spray finishing process and to collect buffing dust. The complete chrome tannery typically has a water-wash system to remove particulates from the finishing spray booth exhausts. The particulates removed are currently a relatively minor source of solid waste. It is anticipated that gradual installation of water-wash collection systems in the few tanneries which do not currently (1974) utilize them, and retrofit installation of the more efficient collection systems which will be required by air pollution regulations in some areas, will not result in an increase in finishing residues by 1977, but will produce an estimated 5 percent increase by 1983.[23]

Buffing dust is currently being effectively collected at a majority of complete chrome tanneries. Wet scrubbers, cyclones, and bag houses are all utilized in tanneries, but wet scrubbers are relatively uncommon. Installation of adequate and/or more effective collection devices at tanneries not currently utilizing effective collection systems will not result in a significant increase in the quantity of buffing dust destined for land disposal by 1977, but will produce an estimated 10 percent increase by 1983.[23]

Water Pollution Control. Treatment of process wastewater generates a substantial quantity of solid waste. Most tanneries (88) in this category currently provide rudimentary screens and sewer sumps for the removal of wastewater solids, and 19 tanneries provide a significantly increased degree of solids removal through the use of screening, primary clarifiers and/or secondary treatment. When 1977 and 1983 effluent limitations are implemented, it is estimated that 25 percent and 45 percent, respectively, of the complete chrome tanneries will provide primary and/or secondary treatment of their wastewater. This yields an approximate 81 percent increase in sludge by 1983, most of which will be due to primary treatment.

Industry Trends. It is estimated that production of leather by complete chrome tanneries will increase 6.2 percent by 1977 and 17 percent by 1983 relative to 1974.[2] This estimate takes into account population growth, growth trends for related consumer industries, projected changes in imports and exports, and the availability of the necessary raw material. It does not take into account any changes in U.S. trade policy.

3.3.5 Typical Plant Summary. The current (1974) and projected (1977 and 1983) waste generation factors of process solid waste and the various types and quantities of potentially hazardous solid waste generated by a typical complete chrome tannery are summarized in Table 17. As indicated in the table, the generation factors for 1974 and 1977 are identical. Finishing residues and buffing dust are the only wastestreams expected to have a higher generation rate in 1983.

3.3.6 EPA Region and National Waste Summary. Table 18 presents the total quantity of process solid waste and the types and quantities of potentially hazardous waste, including their respective hazardous constituents (on a dry weight basis only), currently (1974) produced by complete chrome tanneries. Quantities projected for 1977 and 1983 are presented in Tables 19 and 20, respectively. The methodology used to develop these and similar tables is discussed in Appendix D. As the tables indicate, more than one-half of the potentially hazardous solid waste generated by complete chrome tanneries are produced in Regions I and V. It is also noteworthy that the total quantity of potentially hazardous waste is expected to increase 17 percent by 1977 and 53 percent by 1983 when compared to 1974. Most of these increases will be

TABLE 17

WASTE GENERATION FACTORS FOR A COMPLETE CHROME TANNERY
(All units are kg per 1000 equivalent hides)

Waste Type		1974 & 1977*		1983	
		Wet	Dry	Wet	Dry
Total Process Solid Waste		5,410	1,750	5,420	1,760
Total Potentially Hazardous Solid Waste		4,860	1,300	4,870	1,310
Trimmings & Shavings	Total	1,260	540	1,260	540
	Cr	---	12.1	---	12.1
Unfinished Leather Trim	Total	114	100	114	100
	Cr	---	1.71	---	1.71
	Pb	---	0.31	---	0.13
Buffing Dust	Total	27	25	30	28
	Cr	---	0.54	---	0.59
	Pb	---	0.0018	---	0.002
Finished Leather Trim	Total	220	200	220	200
	Cr	---	4.2	---	4.2
	Pb	---	0.055	---	0.055
Finishing Residues	Total	150	45	158	47
	Cr	---	0.079	---	0.083
	Pb	---	0.165	---	0.17
	Zn	---	0.016	---	0.017
Wastewater Screenings	Total	390	90	390	90
	Cr	---	0.38	---	0.38
	Pb	---	0.016	---	0.016
Wastewater Sludge (from sewer sump)	Total	2,700	300	2,700	300
	Cr	---	7.4	---	7.4
	Pb	---	0.07	---	0.07
	Cu	---	0.51	---	0.51

Source: SCS Engineers

* No processing changes are expected between 1974 and 1977 that would change the generation factors. Thus they are identical.

TABLE 18

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE GENERATED IN 1974 BY COMPLETE CHROME TANNERIES

(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Trim and shavings			Unfinished leather trimmings			
						Total Potentially Hazardous		Constituent	Total Potentially Hazardous		Constituents	
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Wet	Dry	Chromium	Lead
I	ME,VT	11100	3490	10200	2770	2030	870	19.5	183	161	2.75	0.20
	MA	13400	4220	12300	3350	2450	1050	23.6	222	195	3.33	0.24
	NH	8870	2800	8160	2220	1630	697	15.6	147	129	2.21	0.16
II	NY	12900	4070	11900	3230	2370	1010	22.7	214	188	3.21	0.24
	NJ	2030	640	1860	507	372	159	3.57	33.6	29.5	0.50	0.037
III	PA,VA,DE	6370	2010	5860	1590	1170	501	11.2	106	92.7	1.59	0.12
IV & VI	TN,FL,LA	5040	1600	4640	1260	925	396	8.88	83.7	73.4	1.26	0.032
V	OH,MN	5500	1740	5060	1380	1010	432	9.68	91.2	80.0	1.37	0.10
	MI	7880	2490	7250	1970	1450	619	13.9	131	115	1.96	0.14
	WI	21200	6680	19500	5300	3880	1660	37.3	351	308	5.27	0.39
	IL	7110	2250	6540	1780	1300	559	12.5	118	104	1.77	0.13
VII & VIII	NE,MO,UT	1420	447	1300	354	260	111	2.49	23.5	20.6	0.35	0.026
IX	CA	9820	3100	9040	2460	1800	772	17.3	163	143	2.45	0.18
X	AK,WA	192	60.8	177	48.2	35.3	15.1	0.34	3.19	2.80	0.048	0.0035
TOTAL		113000	35600	104000	28200	19500	8850	199	1900	1650	28.0	2.06

TABLE 18
(Continued)

EPA Region(s)	State(s)	Buffing dust				Finished leather trim				Finishing residues				
		Total Potentially Hazardous		Constituents		Total Potentially Hazardous		Constituents		Total Potentially Hazardous		Constituents		
		Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead	Zinc
I	ME,VT	43.4	40.2	0.87	0.0029	354	322	6.76	0.088	241	72.4	0.13	0.27	0.025
	MA	52.6	48.7	1.05	0.0035	428	389	8.18	0.11	292	87.6	0.15	0.32	0.031
	NH	34.9	32.3	0.70	0.0023	284	258	5.42	0.071	194	58.1	0.10	0.21	0.020
II	NY	50.7	46.9	1.01	0.0033	413	375	7.88	0.10	282	84.5	0.15	0.31	0.040
	NJ	7.97	7.38	0.16	0.00053	64.9	59	1.24	0.016	44.3	13.3	0.023	0.049	0.0047
III	PA,VA,DE	25.0	23.2	0.50	0.0017	204	185	3.89	0.051	139	41.7	0.073	0.15	0.015
IV & VI	TN,FL,LA	19.8	18.4	0.40	0.0013	161	147	3.08	0.040	110	33.0	0.058	0.12	0.012
V	OH,MN	21.6	20.0	0.43	0.0014	176	160	3.36	0.044	120	36.0	0.063	0.13	0.013
	MI	31.0	28.7	0.62	0.0020	252	229	4.82	0.063	172	51.3	0.090	0.19	0.018
	WI	83.1	77.0	1.66	0.0055	677	616	12.9	0.17	462	139	0.24	0.51	0.049
	IL	27.9	25.9	0.56	0.0018	228	207	4.35	0.057	155	46.6	0.082	0.17	0.016
VII & VIII	NE,MO,UT	5.56	5.15	0.11	0.00037	45.3	41.2	0.87	0.011	30.9	9.27	0.016	0.034	0.0033
IX	CA	38.6	35.8	0.77	0.0026	315	286	6.01	0.079	215	64.4	0.11	0.24	0.026
X	AK,WA	0.76	0.7	0.015	0.000050	6.16	5.6	0.12	0.0015	4.2	1.26	0.0022	0.0046	0.00044
TOTAL		443	400	8.85	0.029	3610	3280	68.9	0.90	2460	738	1.30	2.71	0.26

TABLE 18
(Continued)

EPA Region(s)	State(s)	Wastewater screenings				Wastewater sludge				
		Total Potentially Hazardous		Constituents		Total Potentially Hazardous		Constituents		
		Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead	Copper
I	ME,VT	628	145	0.61	0.025	6690	1160	24.8	0.22	1.58
	MA	759	175	0.73	0.030	8100	1402	30.0	0.27	1.91
	NH	503	116	0.49	0.020	5370	930	19.9	0.18	1.27
II	NY	732	169	0.71	0.029	7810	1350	28.9	0.26	1.84
	NJ	115	26.6	0.11	0.0046	1210	212	4.54	0.040	0.29
III	PA,VA,DE	362	83.4	0.35	0.015	3860	667	14.3	0.13	0.91
IV & VI	TN,FL, LA	286	66.1	0.28	0.012	3050	528	11.3	0.10	0.72
V	OH,MN	312	72	0.30	0.013	3330	576	12.3	0.11	0.79
	MI	447	103	0.43	0.018	4770	826	17.7	0.16	1.13
	WI	1200	277	1.16	0.048	12800	2200	47.4	0.42	3.02
	IL	404	93.2	0.39	0.016	4310	745	15.9	0.14	1.02
VII & VIII	NE,MO,UT	80.3	18.5	0.078	0.0032	857	148	3,17	0.028	0.20
IX	CA	558	129	0.54	0.022	5950	1030	22.0	0.20	1.40
X	AK,WA	10.9	2.52	0.011	0.00044	116	20.2	0.43	0.0038	0.028
TOTAL		6400	1480	6.17	0.25	68100	11800	252	2.25	16.1

Source: SCS Engineers

TABLE 19

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE ANTICIPATED TO BE GENERATED IN 1977 BY COMPLETE CHROME TANNERIES
(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Trim and shavings			Unfinished leather trimmings			
						Total Potentially Hazardous		Constituent	Total Potentially Hazardous		Constituents	
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Wet	Dry	Chromium	Lead
I	ME,VT	12300	3830	12700	3110	2160	920	20.8	195	171	2.93	0.214
	MA	14900	4690	15300	3760	2610	1110	25.1	236	206	3.54	0.26
	NH	9890	3110	10200	2490	1730	736	15.7	156	137	2.35	0.17
II	NY	14400	4520	14800	3620	2520	1070	24.2	227	199	3.42	0.25
	NJ	2260	711	2320	569	395	168	3.81	35.7	31.3	0.54	0.039
III	PA,VA,DE	7100	2230	7300	1790	1240	528	12.0	112	98.3	1.69	0.12
IV & VI	TN,FL,LA	5620	1770	5780	1420	984	418	9.47	88.8	77.8	1.34	0.098
V	OH,MN	613	1930	6300	1540	1070	456	10.3	96.8	84.8	1.46	0.11
	MI	8790	2760	9040	2210	1540	654	14.8	139	122	2.09	0.15
	WI	23600	7420	24300	5940	4130	1760	39.7	373	326	5.60	0.41
	IL	7930	2490	8160	2000	1390	590	13.4	125	110	1.88	0.14
VII & VIII	NE,MO,UT	1580	496	1620	398	276	117	2.66	24.9	21.8	0.38	0.027
IX	CA	11000	3450	11300	2760	1920	815	18.5	173	152	2.60	0.19
X	AK,WA	214	67.5	221	54.0	37.5	16.0	0.36	3.39	2.97	0.051	0.0037
TOTAL		130000	39600	121000	31700	22000	9450	211	1990	1740	29.9	2.18

TABLE 19
(Continued)

EPA Region(s)	State(s)	Buffing dust				Finished leather trim				Finishing residues				
		Total Potentially Hazardous		Constituents		Total Potentially Hazardous		Constituents		Total Potentially Hazardous		Constituents		
		Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead	Zinc
I	ME,VT	4.7	43	0.92	0.009	377	341	7.24	0.093	257	77.2	0.13	0.28	0.027
	MA	56.5	52.6	1.11	0.0037	456	413	8.76	0.11	312	93.5	0.16	0.34	0.033
	NH	37.4	34.9	0.74	0.0024	302	274	5.81	0.075	207	62.0	0.11	0.23	0.022
II	NY	54.4	50.7	1.07	0.0036	439	398	8.45	0.11	300	90.1	0.16	0.33	0.032
	NJ	8.56	7.97	0.17	0.00056	69.0	62.5	1.33	0.017	47.2	14.2	0.025	0.052	0.0050
III	PA,VA,DE	26.9	25.0	0.53	0.0018	217	197	4.17	0.054	148	44.5	0.078	0.16	0.016
IV & VI	TN,FL,LA	21.3	19.8	0.42	0.0014	172	156	3.30	0.043	117	35.2	0.061	0.13	0.012
V	OH,MN	23.2	21.6	0.46	0.0015	187	170	3.60	0.046	128	38.4	0.067	0.14	0.013
	MI	33.3	31.0	0.65	0.0022	268	243	5.16	0.067	184	54.7	0.096	0.20	0.019
	WI	89.3	83.1	1.76	0.0058	720	653	13.9	0.18	493	148	0.26	0.54	0.052
	IL	30.0	27.9	0.59	0.0020	242	219	4.66	0.060	166	49.7	0.087	0.18	0.017
VII & VIII	NE,MO,UT	5.97	5.56	0.12	0.00039	48.2	43.7	0.93	0.012	33.0	9.89	0.017	0.036	0.0035
IX	CA	41.5	38.6	0.82	0.0027	335	303	6.44	0.083	229	68.6	0.12	0.25	0.024
X	AK,WA	0.81	0.76	0.016	0.000052	6.55	5.94	0.13	0.0016	4.48	1.34	0.0023	0.0049	0.00047
TOTAL		476	443	9.36	0.031	3840	3480	73.9	0.95	2630	787	1.37	2.87	0.27

TABLE 19
(Continued)

EPA Region(s)	State(s)	Wastewater screenings				Wastewater sludge				
		Total Potentially Hazardous		Constituents		Total Potentially Hazardous		Constituents		
		Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead	Copper
I	ME,VT	666	154	0.64	0.027	7710	1340	28.5	0.25	1.82
	MA	806	187	0.78	0.032	9330	1620	34.5	0.31	2.20
	NH	534	124	0.52	0.021	6180	1070	22.9	0.20	1.46
II	NY	777	180	0.75	0.031	8990	1560	33.2	0.30	2.12
	NJ	122	28.3	0.12	0.0049	1410	245	5.22	0.047	0.33
III	PA,VA,DE	384	89.0	0.37	0.015	4440	769	16.4	0.15	1.05
IV & VI	TN,FL,LA	304	70.5	0.29	0.012	3520	609	13.0	0.12	0.83
V	OH,MN	331	76.8	0.32	0.013	3830	664	14.2	0.13	0.91
	MI	475	110	0.46	0.019	5490	952	20.3	0.16	1.30
	WI	1270	296	1.23	0.051	14700	2560	54.5	0.49	3.48
	IL	428	99.4	0.41	0.017	49600	859	18.3	0.16	1.17
VII & VIII	NE,MO,UT	85.3	19.8	0.082	0.0034	987	171	3.65	0.033	0.23
IX	CA	592	137	0.57	0.024	6850	1190	25.3	0.23	1.62
X	AK,WA	11.6	2.69	0.011	0.00047	134	23.2	0.50	0.0044	0.032
TOTAL		6790	1580	6.57	0.28	123000	13600	290	2.59	18.6

Source: SCS Engineers

TABLE 20

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE ANTICIPATED TO BE GENERATED IN 1983 BY COMPLETE CHROME TANNERIES
(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Trim and shavings			Unfinished leather trimmings			
						Total Potentially Hazardous		Constituent	Total Potentially Hazardous		Constituents	
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Wet	Dry	Chromium	Lead
I	ME,VT	16500	5110	15400	4260	2370	1020	22.8	214	188	3.22	0.23
	MA	19940	6180	18700	5150	2870	1230	27.6	259	228	3.69	0.28
	NH	13200	4100	12400	3420	1900	816	18.3	172	151	2.58	0.19
II	NY	19200	5960	18000	4970	2770	1190	26.7	250	220	3.75	0.27
	NJ	3020	936	2830	781	435	186	4.19	39.2	34.5	0.59	0.043
III	PA,VA,DE	9490	2940	8900	2450	1370	586	13.2	123	108	1.85	0.14
IV & VI	TN,FL,LA	7520	2330	7040	1940	1080	464	10.4	97.6	85.9	1.47	0.11
V	OH,MN	8190	2540	7680	2120	1180	506	11.4	106	93.6	1.6	0.12
	MI	11700	3640	11000	3040	1690	725	16.3	153	134	2.29	0.17
	WI	31500	9770	29500	8150	4540	1950	43.7	410	360	6.16	0.45
	IL	10600	3290	9930	2740	1530	654	14.7	138	121	2.07	0.15
VII & VIII	NE,MO,UT	2110	654	1980	545	304	130	2.93	27.4	24.1	0.41	0.030
IX	CA	14600	4540	13700	3790	2110	904	20.3	190	167	2.86	0.21
X	AK,WA	287	88.9	269	74.1	41.3	17.7	0.40	3.72	3.28	0.056	0.0040
TOTAL		167000	52100	158000	43400	24200	10300	233	2180	1920	32.8	2.40

TABLE 20
(Continued)

EPA Region(s)	State(s)	Buffing dust				Finished leather trim				Finishing residues				
		Total Potentially Hazardous		Constituents		Total Potentially Hazardous		Constituents		Total Potentially Hazardous		Constituents		
		Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead	Zinc
I	ME,VT	54.7	51.5	1.1	0.0036	414	377	7.88	0.10	294	88	0.15	0.32	0.031
	MA	66.2	62.3	1.34	0.0044	500	456	9.54	0.13	356	107	0.19	0.39	0.037
	NH	43.9	41.3	0.89	0.0029	332	302	6.33	0.083	236	71.0	0.12	0.26	0.025
II	NY	63.8	60.1	1.30	0.0042	482	439	9.20	0.12	343	103	0.18	0.38	0.036
	NJ	10.0	9.44	0.20	0.00067	75.8	69.0	1.45	0.019	54.0	16.2	0.028	0.059	0.0056
III	PA,VA,DE	31.5	30.0	0.64	0.0021	238	217	4.54	0.059	170	51.0	0.089	0.19	0.018
IV & VI	TN,FL,LA	25.0	23.5	0.51	0.0017	189	172	3.60	0.047	134	40.4	0.071	0.15	0.014
V	OH,MN	27.2	25.6	0.55	0.0018	206	187	3.92	0.051	146	44	0.077	0.16	0.015
	MI	39.0	36.7	0.79	0.0026	295	268	5.62	0.073	210	63.1	0.11	0.23	0.022
	WI	105	98.5	2.12	0.0070	791	720	15.1	0.20	563	169	0.23	0.62	0.059
	IL	35.2	33.1	0.71	0.0023	266	242	5.1	0.066	189	56.9	0.099	0.21	0.020
VII & VIII	NE,MO,UT	7.00	6.59	0.14	0.00047	52.9	48.2	1.01	0.013	37.7	11.3	0.020	0.041	0.0039
IX	CA	48.6	45.8	0.99	0.0032	368	335	7.01	0.092	262	78.7	0.14	0.29	0.027
X	AK,WA	0.95	0.90	0.019	0.000063	7.20	6.55	0.14	0.0018	5.12	1.54	0.0027	0.0056	0.00053
TOTAL		558	525	11.3	0.037	4220	3840	80.3	1.05	3000	902	1.51	3.28	0.31

TABLE 20
(Continued)

EPA Region(s)	State(s)	Wastewater screenings				Wastewater sludge				
		Total Potentially Hazardous		Constituents		Total Potentially Hazardous		Constituents		
		Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead	Copper
I	ME,VT	735	169	0.71	0.029	11400	1970	42.2	0.37	2.69
	MA	890	204	0.86	0.036	13800	2380	51.0	0.45	3.25
	NH	590	136	0.57	0.024	9130	1580	33.8	0.30	2.16
II	NY	858	197	0.83	0.034	13300	2300	49.2	0.44	3.13
	NJ	135	31.0	0.13	0.0054	2090	361	7.73	0.069	0.49
III	PA,VA,DE	424	97.3	0.41	0.017	6560	1130	24.3	0.22	1.55
IV & VI	TN,FL,LA	335	77.1	0.32	0.013	5190	898	19.2	0.17	1.23
V	OH,MN	366	84	0.35	0.015	5660	979	21.0	0.19	1.34
	MI	524	120	0.51	0.021	8110	1400	30.1	0.27	1.92
	WI	1410	323	1.35	0.056	21800	3770	80.7	0.72	5.14
	IL	473	109	0.46	0.019	7320	1270	27.1	0.24	1.73
VII & VIII	NE,MO,UT	94.1	21.6	0.091	0.0038	1460	252	5.40	0.048	0.34
IX	CA	654	150	0.63	0.026	10100	1750	37.5	0.33	2.39
X	AK,WA	12.8	2.94	0.012	0.00051	198	34.3	0.734	0.0065	0.047
TOTAL		7500	1720	7.22	0.30	116000	20100	429	3.82	27.4

Source: SCS Engineers

due to wider use of primary and secondary wastewater treatment with attendant increased sludge generation as noted in Sections 3.3.2 and 3.3.4.

3.4 Vegetable Tannery

3.4.1 Plant Operations. This portion of the industry includes those plants which convert cattlehides to leather using the vegetable tanning process.

Brine cured, prefleshed cattlehides are first soaked after receipt at the tannery to return moisture to the hides. The hides are then treated with lime and Na_2S, $NaHS$, and soda ash to chemically destroy the hair folicles. The hair is then removed mechanically from the hides, after which the flesh is removed from the inner side of the hide. Following the fleshing operation, the hides are bated (treated with an enzyme), pickled (treated with acid), and then tanned. The tanning process involves soaking the hides in a slurry of vegetable extracts for approximately two weeks.

The hides are then bleached in order to lighten the surface colors, subsequently treated with fatliquors (animal and vegetable oils) in order to return some of the natural flexibility to the hide fibers, and then dried. The resulting leather is mechanically split to obtain a uniform thickness and physically conditioned to achieve the desired degree of flexibility. The leather may then be buffed to remove unsightly imperfections and trimmed to remove ragged edges in final preparation for sale. A typical vegetable tannery processed 151,000 equivalent hides in 1974.[2]

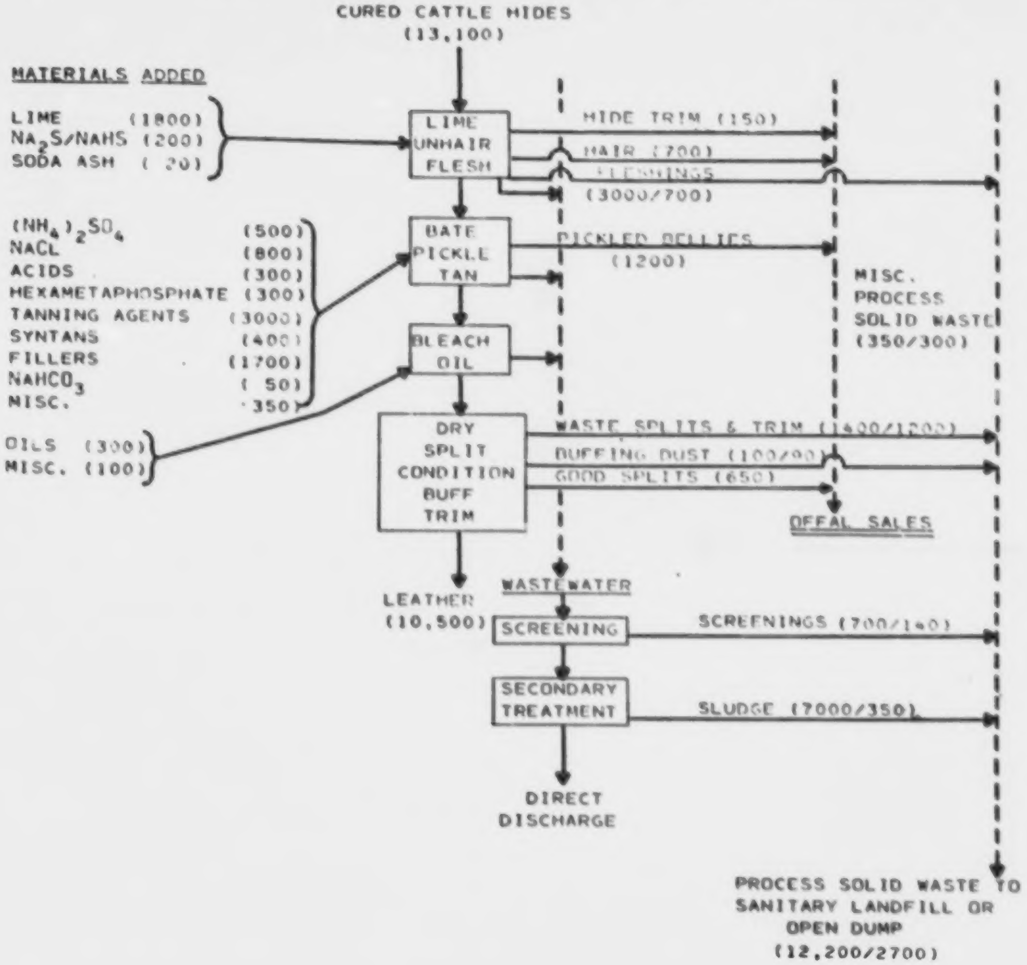
Figure 6 is a process flow diagram for a typical vegetable tannery indicating the types and quantities of raw materials and products involved, the basic production operations performed, and the types and quantities of waste resulting from the production process.

3.4.2 Process Solid Waste.

Fleshings. An average of approximately 70 percent of the cattlehides received are prefleshed at the slaughterhouse. Any one plant may use prefleshed hides and hides which have not been fleshed, or only one type. As a result, the quantity of fleshings generated by plants vary widely. However, virtually all vegetable tanners find it necessary to flesh hides which they have received; thus, some fleshings are generated by virtually all vegetable tanneries. A typical vegetable tannery generates fleshings at a rate of 3,000 (wet)/700 (dry) kg per 1000 equivalent hides processed. Annually 9,500 (wet)/ 2,200 (dry) metric tons of fleshings are produced. Analysis of one sample collected from the pits below the fleshing indicated that this wastestream is not potentially hazardous.

FIGURE 6

PROCESS FLOW DIAGRAM
TYPICAL VEGETABLE TANNERY
(All units are kg/1000 equivalent hides on a dry weight basis except solid wastes which are given on a wet/dry basis)


CURED CATTLE HIDES (13,100)
MATERIALS ADDED
LIME (1800)
NA$_2$S/NAHS (200)
SODA ASH (20)
LIME UNHAIR FLESH
HIDE TRIM (150)
HAIR (700)
FLESHINGS (3000/700)
(NH$_4$)$_2$SO$_4$ (500)
NACL (800)
ACIDS (300)
HEXAMETAPHOSPHATE (300)
TANNING AGENTS (3000)
SYNTANS (400)
FILLERS (1700)
NAHCO$_3$ (50)
MISC. 350)
BATE PICKLE TAN
PICKLED BELLIES (1200)
MISC. PROCESS SOLID WASTE (350/300)
BLEACH OIL
OILS (300)
MISC. (100)
DRY SPLIT CONDITION BUFF TRIM
WASTE SPLITS & TRIM (1400/1200)
BUFFING DUST (100/90)
GOOD SPLITS (650)
OFFAL SALES
LEATHER (10,500)
WASTEWATER
SCREENING
SCREENINGS (700/140)
SECONDARY TREATMENT
SLUDGE (7000/350)
DIRECT DISCHARGE
PROCESS SOLID WASTE TO SANITARY LANDFILL OR OPEN DUMP (12,200/2700)

Waste Splits and Trimmings. Waste splits and trimmings are composed of leather which is removed from the tanned hide in order to obtain a uniform thickness and satisfy purchaser's cutting requirements. A typical vegetable tannery generated 1,400 (wet)/1,200 (dry) kg per 1000 equivalent hides processed which amounts to 4,400 (wet)/ 3,800 (dry) metric tons per year nationwide. This waste material is primarily animal protein which has been cross-linked by vegetable tanning agents in order to eliminate its susceptibility to bacteriological decomposition. Analysis of three samples collected from below the splitting machines and from fiber barrels in the trimming department indicated that this wastestream is not potentially hazardous.

Buffing Dust. A typical vegetable tannery generates 100 (wet)/90 (dry) kg per 1000 equivalent hides processed which amounts to 320 (wet)/290 (dry) metric tons annually nationwide. Buffing dust is generated in sanding operations performed to remove certain imperfections from the surface of the leather. Analysis of three samples taken from the buffing dust collection equipment indicated that this wastestream is not potentially hazardous.

Wastewater Screenings. Virtually all vegetable tanneries perform some kind of screening of their wastewater prior to discharge or further treatment. A representative vegetable tannery generates 2,800 (wet)/140 (dry) kg of screenings per 1000 equivalent hides processed. Samples of screenings, which were composed mostly of hair and flesh, were collected from the wastewater screens at two tanneries. Analysis of the two screening samples collected indicated that this wastestream is not potentially hazardous.

Wastewater Treatment Sludges. A representative tannery produces 7,000 (wet)/350 (dry) kg of sludge per 1000 equivalent hides processed which amounts to 22,100 (wet)/ 1,100 (dry) metric tons annually nationwide. Sludge samples were collected from lagoons at three vegetable tanneries. Analysis of these samples indicated that this wastestream is not potentially hazardous.

Miscellaneous Process Solid Waste. Miscellaneous process solid waste is generated at a rate of 350 (wet)/ 300 (dry) kg per 1000 equivalent hides processed, which on a national basis amounts to 1,100 (wet)/950 (dry) metric tons per year. This waste is composed of fiber drums, paper bags, wooden barrels in which the pickled skins are received, and general plant floor sweepings, and they do not contain constituents at potentially hazardous concentrations.

3.4.3 Factors Affecting Future Solid Waste Generation.

Air Pollution Control. Most vegetable tanneries utilize moderately effective equipment to collect the leather dust which is produced by buffing, and this situation is not expected to change by 1977. However, it is anticipated that by 1983, retrofit installation of more effective buffing dust collection devices at vegetable tanneries will result in an increase of 15 percent in the quantity of buffing dust destined for land disposal.[23]

Water Pollution Control. Screenings and wastewater treatment sludges destined for land disposal are currently generated as a result of wastewater treatment systems at an average vegetable tannery. Since Federal effluent limitation guidelines are currently under litigation, it is anticipated that the type and extent of wastewater treatment at vegetable tanneries will not change significantly by 1977. However, it is anticipated that the improved quality of wastewater discharged from vegetable tanneries as the result of future Federal and State water pollution control regulations will result in a 15 percent increase in the quantity of vegetable tannery wastewater sludges destined for land disposal by 1983.

On the other hand, it is anticipated that efforts will be made to reduce chemical usage in vegetable tanneries by 1983. It is estimated that chemical conservation techniques will nullify the increase in the quantity of sludge to be generated by 1983 as a result of water pollution control regulations.

Industry Trends. Vegetable tanned leather is utilized primarily for footwear. It is assumed that the growth and consumption of footwear in the United States will be approximately equal to the growth in population, which is approximately 1 percent per year. It is also assumed that the growth rate of the penetration of imported footwear will increase 3 percent per year through 1983.[2] Therefore, the production of vegetable tanned leather in the United States is expected to decrease at the rate of 2 percent annually through 1983.

3.4.4 Typical Plant Waste Summary. The current (1974) and projected (1977 and 1983) generation rates of process solid waste in kg per 1000 equivalent hides processed by a typical vegetable tannery, are as follows:

1974 and 1977		1983	
Wet	Dry	Wet	Dry
12,200	2,700	13,000	2,750

As indicated, a typical vegetable tannery generates more total process solid waste per 1000 equivalent hides on a wet weight basis than any other type of tannery, although none of the waste is potentially hazardous.

3.4.5 EPA Region and National Waste Summary. Table 21 presents the total quantity of process solid waste currently (1974) produced, and the quantities projected for 1977 and 1983. It is noteworthy that vegetable tanneries produce more process solid waste on a national basis than any other type of tannery, except complete chrome tanneries.

3.5 Sheepskin Tannery

3.5.1 Plant Operations. The major raw material of sheepskin tanneries is imported, pickled sheepskins. However, some sheepskin tanneries which utilize fresh or cured sheepskins as their raw material have beamhouses where the hides are soaked, fleshed, and unhaired in preparation for tanning.

Pickled sheepskins are normally received by the tannery in 20 kg wooden barrels. The pickled skins are removed from their shipping containers and placed in rotating wooden drums in which they are degreased, normally with a solvent degreasing system, and less frequently with water. In solvent degreasing systems, the solvent is recovered and sold to be reprocessed. In water degreasing systems, a detergent solution removes the grease from the skins.

The degreased skins are then chrome tanned with a basic chromic sulfate solution. In some cases, formaldehyde is also used in the tanning process, which decreases the amount of chromium required. Most of the formaldehyde is incorporated into the leather with excess discharged as part of the wastewater. If the skins require fleshing, they are removed from the tanning drums and mechanically fleshed. Following fleshing, or without being removed from the tanning drums if fleshing is not required, the skins are retanned with vegetable or synthetic tanning agents, colored with dyes and pigments, and fatliquored. The fatliquoring process involves the addition of oils to lubricate the fibers of the skins so that after drying they will be able to slide over one another. In addition to regulating the pliability of the leather, the fatliquor increases its tensil strength.

Following fatliquoring, the skins are stretched on a metal frame and then dried in an oven. The resulting leather is conditioned mechanically to impart the desired degree of softness. The skins are then mechanically sanded (buffed) to remove imperfections in the grain surface, or to produce the desired nap if the leather is to be a suede. Finally, the leather is trimmed to remove ragged edges and packaged for shipment to the customer. A typical sheepskin tannery processed 200,000 equivalent hides in 1974.[2]

TABLE 21

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE GENERATED BY VEGETABLE TANNERIES

(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	1974 Total Process Solid Waste		1977 Total Process Solid Waste		1983 Total Process Solid Waste	
		Wet	Dry	Wet	Dry	Wet	Dry
III	PA	9890	2190	9300	2060	8780	1860
	VA,WV,MD	14200	3140	13300	2950	12600	2660
V	IN,OH	1180	261	1110	246	1050	222
IV	KY	5480	1210	5160	1140	4870	1030
	GA,TN,NC	7740	1720	7280	1610	6880	1460
VI,VIII & X	OR,TX,MO	1230	272	1160	256	1090	230
TOTAL		39700	8790	37300	8260	35300	7460

Source: SCS Engineers

Figure 7, a process flow diagram for a typical sheepskin tannery, indicates the basic production operations performed, the types and quantities of raw materials and products involved, and the types and quantities of waste products resulting from production process.

3.5.2 Potentially Hazardous Solid Waste. As indicated in Figure 7, several kinds of solid waste is generated. The potentially hazardous wastestreams are discussed below.

Fleshings. Mechanical fleshing of sheepskins to remove excess fatty material from the flesh side of the skin is normally performed immediately following chrome tanning. The typical sheepskin tannery using pickled sheepskin as the raw material generates 1,200 (wet)/300 (dry) kg of fleshings per 1000 equivalent hides processed. On a national basis, sheepskin tanneries produce 2,990 (wet)/ 747 (dry) metric tons of fleshings per year.

Chrome fleshing samples were collected from below sheepskin fleshing machines at three tanneries. Although the fleshings consist primarily of animal fat and protein, analysis indicated that they also contain 4,030 (wet)/16,300 (dry) mg/kg chromium.

Buffing Dust. Mechanical sanding (buffing) of sheepskin leather produces 100 (wet)/90 (dry) kg of fine leather dust per 1000 equivalent hides processed, which on a national basis amounts to 140 (wet)/125 (dry) metric tons per year. Samples were taken from the buffing dust collection devices at three sheepskin tanneries. Analysis of these samples indicated the presence of hazardous constituents as follows:

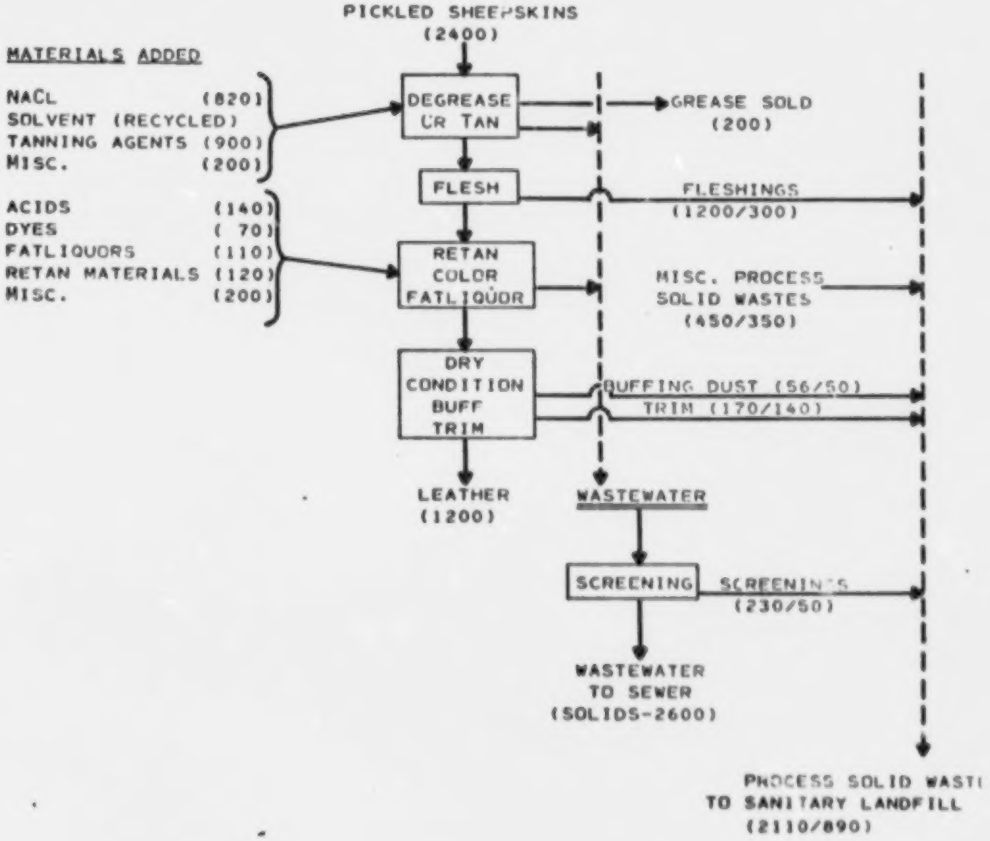
Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry	Concentration range (mg/kg) Dry
Chromium	17,500	19,000	6,700 - 31,000
Lead	620	670	340 - 990
Copper	980	1,070	130 - 2,000
Zinc	280	310	Not detected - 620

Leather Trim. Sheepskins are normally trimmed before packaging to remove the ragged edges from the skins. This trimming operation produces 170 (wet)/140 (dry) kg of leather trim per 1000 equivalent hides processed at a typical sheepskin tannery, which on a national basis amounts to 424 (wet)/349 (dry) metric tons per year. Samples were collected from the fiber drums in the trimming departments of two sheepskin tanneries. An analysis of these samples

FIGURE 7

PROCESS FLOW DIAGRAM
TYPICAL SHEEPSKIN TANNERY

(All units are kg/1000 equivalent hides on a dry weight basis
except solid wastes which are given on a wet/dry basis)


PICKLED SHEEPSKINS
(2400)
MATERIALS ADDED
NACL (820)
SOLVENT (RECYCLED)
TANNING AGENTS (900)
MISC. (200)
ACIDS (140)
DYES (70)
FATLIQUORS (110)
RETAN MATERIALS (120)
MISC. (200)
DEGREASE OR TAN
GREASE SOLD
(200)
FLESH
FLESHINGS
(1200/300)
RETAN
COLOR
FATLIQUOR
MISC. PROCESS
SOLID WASTES
(450/350)
DRY
CONDITION
BUFF
TRIM
BUFFING DUST (56/50)
TRIM (170/140)
LEATHER
(1200)
WASTEWATER
SCREENING
SCREENINGS
(230/50)
WASTEWATER
TO SEWER
(SOLIDS-2600)
PROCESS SOLID WASTE
TO SANITARY LANDFILL
(2110/890)

indicated the presence of the following hazardous constituents:

Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry	Concentration range (mg/kg) Dry
Chromium	37,000	44,000	12,000 - 76,000
Lead	280	330	94 - 560
Copper	140	170	32 - 300

Wastewater Screenings. Essentially all sheepskin tanneries screen their wastewater prior to discharge or further treatment. A typical plant generates 230 (wet)/ 50 (dry) kg per 1000 equivalent hides processed, which on a national basis amounts to 574 (wet)/125 (dry) metric tons per year. A sample was taken from the wastewater screens at one sheepskin tannery. The screenings are composed primarily of small pieces of leather which are torn off the sheepskins at various points in the production process, and contain the following hazardous constituents:

Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry
Chromium	7,200	33,000
Copper	50	220

3.5.3 Non-Hazardous Solid Waste.

Miscellaneous process solid waste is generated at a rate of 390 (wet)/350 (dry) kg per 1000 equivalent hides processed, which on a national basis amounts to 1,130 (wet)/870 (dry) metric tons per year. This waste is composed of fiber drums, paper bags, wooden barrels in which the pickled skins are received, and general plant floor sweepings, and they do not contain constituents at potentially hazardous concentrations.

3.5.4 Factors Affecting Future Solid Waste Generation.

Air Pollution Control. The only significant source of air pollution from sheepskin tanneries is leather dust which is generated by the buffing operation, and this is currently (1974) being controlled adequately by most tanneries of this type. Retrofit installation of more efficient collection systems which may be required by air pollution control regulations in certain areas are not expected to significantly increase the quantity of buffing dust destined for land disposal by 1977. However, it is estimated that more efficient buffing dust collection systems will result in a

10 percent increase in buffing dust destined for land disposal by 1983.[23]

Water Pollution Control. The only solid waste currently generated as a result of wastewater treatment at most sheepskin tanneries is screenings. Since Federal effluent limitation guidelines and pretreatment standards for the tanning industry are currently under litigation, it is anticipated that wastewater treatment at sheepskin tanneries in 1977 will be limited to screening. However, it is estimated that by 1983, as surcharges and pretreatment guidelines are established, approximately 10 percent of sheepskin tanneries will be using primary pretreatment to remove solids from their wastewaters. Although this figure may seem low, it should be noted that the only likely candidates for primary pretreatment are the sheepskin tanneries with high suspended solids in their wastewater, i.e., those few operations with beamhouses . It is estimated that this will result in the generation of 1,500 (wet)/150 (dry) kg of sludge per 1000 equivalent hides processed, which on a national basis will amount to 236 (wet)/24 (dry) metric tons per year (1983) from the 10 percent of sheepskin tanneries with primary pretreatment.

Industry Trends. It is estimated that the production of sheep leather will decrease at the rate of 5 percent per year through 1983.[2] This decrease in sheepskin leather production is expected to result from increased importation of sheepskin leather products. The supply of sheepskins for tanning is decreasing as a result of these raw materials being processed in the countries of origin.

3.5.5 Typical Plant Waste Summary. Table 22 presents the current (1974) and projected (1977 and 1983) generation factors for process solid waste and the various types of potentially hazardous solid waste generated by a typical sheepskin tannery. The increase in potentially hazardous solid waste per 1000 equivalent hides anticipated for 1983 is primarily the result of the installation of a sewer sump by a typical sheepskin tannery to remove wastewater solids in order to reduce sewer surcharges.

3.5.6 EPA Region and National Waste Summary. The current (1974) quantity of process solid waste and the types and quantities of potentially hazardous waste, including hazardous constituents, generated on an EPA Region and national basis are presented in Table 23. Quantities projected for 1977 and 1983 are indicated in Tables 24 and 25 , respectively. Examination of these tables shows that sheepskin tannery waste generation is concentrated in Regions I and II. In

TABLE 22

WASTE GENERATION FACTORS FOR A TYPICAL SHEEPSKIN TANNERY

(All units are kg per 1000 equivalent hides)

Waste Type		1974 & 1977*		1983	
		Wet	Dry	Wet	Dry
Total Process Solid Waste		2,100	890	2,270	910
Total Potentially Hazardous Solid Waste		1,660	540	1,820	560
Chrome Fleshing	Total	1,200	300	1,200	300
	Cr	---	4.8	---	4.8
Unfinished Leather Trim	Total	170	140	170	140
	Cr	---	0.63	---	0.63
	Cu	---	0.048	---	0.048
	Pb	---	0.024	---	0.024
Buffing Dust	Total	56	50	62	55
	Cr	---	0.98	---	1.08
	Pb	---	0.035	---	0.039
	Cu	---	0.055	---	0.061
	Zn	---	0.016	---	0.018
Wastewater Screenings	Total	230	50	230	50
	Cr	---	1.66	---	1.66
	Cu	---	0.012	---	0.012
Wastewater Sludge (from sewer sump)	Total	---	---	150	15
	Cr	---	---	---	0.41
	Cu	---	---	---	0.029
	Pb	---	---	---	0.0044

Source: SCS Engineers

* No processing changes are expected between 1974 and 1977 that would change the generation factors. Thus they are identical.

TABLE 23

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE GENERATED IN 1974 BY SHEEPSKIN TANNERIES
(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Chrome fleshings			Unfinished leather trimmings				
						Total Potentially Hazardous		Constituent	Total Potentially Hazardous		Constituents		
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Wet	Dry	Chromium	Copper	Lead
I	ME,NH MA	1550 1440	653 608	1220 1130	396 369	881 820	220 205	3.52 3.28	125 116	103 95.6	0.46 0.43	0.035 0.033	0.018 0.016
II	NY,NJ	1800	757	1410	460	1020	255	4.08	145	119	0.54	0.041	0.020
III	PA	165	69.7	130	42.3	94.0	23.5	0.38	13.3	11.0	0.049	0.0037	0.0019
IV & VI	FL,TX	88.6	37.4	69.6	22.7	50.4	12.6	0.20	7.14	5.88	0.027	0.0020	0.0010
V & VII	WI,MN,IA	219	92.6	172	56.2	125	31.2	0.50	17.7	14.6	0.066	0.0050	0.0024
TOTAL		5260	2220	4130	1350	2990	747	12.0	424	349	1.57	0.12	0.059

EPA Region(s)	State(s)	Buffing dust						Wastewater screenings			
		Total Potentially Hazardous		Constituents				Total Potentially Hazardous		Constituents	
		Wet	Dry	Chromium	Lead	Copper	Zinc	Wet	Dry	Chromium	Copper
I	ME,NH MA	41.1 38.2	36.7 34.2	0.72 0.67	0.026 0.024	0.040 0.039	0.0115 0.011	169 157	36.7 34.2	1.22 1.13	0.0084 0.0079
II	NY,NJ	47.7	42.6	0.83	0.030	0.047	0.013	196	42.6	1.41	0.0098
III	PA	4.38	3.92	0.077	0.0027	0.0043	0.0012	18.0	3.92	0.13	0.00090
IV & VI	FL,TX	2.35	2.10	0.041	0.0015	0.0023	0.00066	9.66	2.1	0.070	0.00048
V & VII	WI,MN,IA	5.82	5.20	0.10	0.0036	0.0057	0.0016	23.9	5.2	0.17	0.0012
TOTAL		140	125	2.44	0.087	0.14	0.039	574	125	4.13	0.029

Source: SCS Engineers

TABLE 24

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE ANTICIPATED TO BE GENERATED IN 1977 BY SHEEPSKIN TANNERIES
(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Chrome fleshings			Unfinished leather trimmings				
						Total Potentially Hazardous		Constituent	Total Potentially Hazardous		Constituents		
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Wet	Dry	Chromium	Copper	Lead
I	ME,NH	1330	562	1040	341	757	189	3.03	107	88.3	0.40	0.030	0.015
	MA	1240	523	974	318	706	176	2.82	100	82.3	0.37	0.028	0.014
II	NY,NJ	1540	651	1210	395	878	220	3.51	124	102	0.46	0.035	0.017
III	PA	141	59.6	111	36.2	80.4	20.1	0.32	11.4	9.38	0.042	0.0032	0.0016
IV & VI	FL,TX	76	32	59.6	19.4	43.2	10.8	0.17	6.12	5.04	0.023	0.0017	0.00086
V & VII	WI,MN,IA	188	79.2	147	48.1	107	26.7	0.43	15.1	12.5	0.056	0.0042	0.0021
TOTAL		4520	1910	3540	1160	2570	643	10.3	364	300	1.35	0.10	0.077

EPA Region(s)	State(s)	Buffing dust						Wastewater screenings			
		Total Potentially Hazardous		Constituents				Total Potentially Hazardous		Constituents	
		Wet	Dry	Chromium	Lead	Copper	Zinc	Wet	Dry	Chromium	Copper
I	ME,NH	35.3	31.6	0.62	0.022	0.035	0.0099	145	31.6	1.04	0.0073
	MA	32.9	29.4	0.58	0.020	0.032	0.0092	135	29.4	0.97	0.0068
II	NY,NJ	41.0	36.6	0.72	0.025	0.040	0.012	168	36.6	1.21	0.0084
III	PA	3.75	3.35	0.066	0.0023	0.0037	0.0011	15.4	3.35	0.11	0.00077
IV & VI	FL,TX	2.02	1.80	0.035	0.0012	0.0020	0.00057	8.28	1.8	0.060	0.00041
V & VII	WI,MN,IA	4.98	4.45	0.087	0.0031	0.0049	0.0014	20.5	4.45	0.15	0.0010
TOTAL		120	107	2.10	0.074	0.12	0.034	492	107	3.54	0.025

Source: SCS Engineers

TABLE 25

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE ANTICIPATED TO BE GENERATED IN 1983 BY SHEEPSKIN TANNERIES
(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Chrome fleshings: Total Potentially Hazardous		Chrome fleshings: Constituent	Unfinished leather trimmings: Total Potentially Hazardous		Unfinished leather trimmings: Constituents		
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Wet	Dry	Chromium	Copper	Lead
I	ME,NH MA	1590 1610	427 398	860 819	265 247	555 516	139 129	2.22 2.06	78.5 73.1	64.6 60.1	0.29 0.27	0.022 0.021	0.011 0.010
II	NY,NJ	1260	495	1020	307	644	161	2.57	91.1	74.9	0.34	0.026	0.012
III	PA	116	45.6	93.9	28.3	59.2	14.8	0.24	8.38	6.89	0.031	0.0024	0.0012
IV & VI	FL,TX	62.3	24.4	50.4	15.2	31.8	7.94	0.13	4.49	3.70	0.017	0.0013	0.0006
V & VII	WI,MN,IA	154	66.5	125	37.5	78.6	19.7	0.31	11.1	9.15	0.042	0.0031	0.0016
TOTAL		3690	1450	2990	900	1880	471	7.53	267	219	1.00	0.075	0.037

EPA Region(s)	State(s)	Buffing dust: Total Potentially Hazardous		Buffing dust: Constituents				Wastewater screenings: Total Potentially Hazardous		Wastewater screenings: Constituents		Wastewater sludge: Total Potentially Hazardous		Wastewater sludge: Constituents		
		Wet	Dry	Chromium	Lead	Copper	Zinc	Wet	Dry	Chromium	Cooper	Wet	Dry	Chromium	Copper	Lead
I	ME,NH MA	30.1 28.0	27.2 25.3	0.53 0.49	0.019 0.017	0.029 0.027	0.0084 0.0079	106 99.0	23.5 21.9	0.76 0.71	0.0053 0.0049	110 102	11.0 10.2	0.30 0.28	0.021 0.020	0.0032 0.0030
II	NY,NJ	34.9	31.5	0.61	0.022	0.034	0.0098	123	27.2	0.89	0.0061	128	12.8	0.35	0.025	0.0037
III	PA	3.21	2.90	0.056	0.0020	0.0031	0.00090	11.4	2.51	0.081	0.00056	11.7	1.17	0.032	0.0023	0.00035
IV & VI	FL,TX	1.72	1.55	0.030	0.0011	0.0017	0.00048	6.09	1.34	0.044	0.00030	6.3	0.63	0.017	0.0012	0.00019
V & VI	WI,MN,IA	4.26	3.85	0.075	0.0026	0.0042	0.0012	15.1	3.33	0.11	0.0065	15.6	1.56	0.042	0.0030	0.00046
TOTAL		102	92.3	1.79	0.063	0.0999	0.0287	361	79.8	2.6	0.018	374	37.4	1.01	0.072	0.011

Source: SCS Engineers

addition, the tables indicate that the total quantity of potentially hazardous solid waste is anticipated to decrease by 14 percent by 1977, and 30 percent by 1983, primarily as a result of decreasing production.

3.6 Split Tannery

3.6.1 Plant Operations. Split tanneries purchase splits or blue drops from complete chrome tanneries and further process them into suede leather.

The production process of a typical split tannery is summarized in Figure 8 and described below. Blue drops are received at the split tannery wrapped in plastic to insure that they do not dry out. The splits are trimmed to remove portions which are too thin to process and then sorted by thickness. The splits are then re-split to obtain a uniform thickness, and subsequently shaved to obtain the exact thickness desired. The splits are then retanned, colored, and fatliquored in a manner similar to that used to produce chrome tanned grain leather. Following fatliquoring, the splits are pasted on large plates or stretched on metal frames and then dried in an oven. The resulting suede leather is buffed to improve the appearance and obtain a uniform nap. After trimming off ragged edges, the splits are ready for packaging and shipment to the customer. A typical split tannery processed 400,000 equivalent hides in 1974.[2]

Figure 8 also shows the basic production operations performed, the types and quantities of raw materials and products involved, and the types and quantities of waste products.

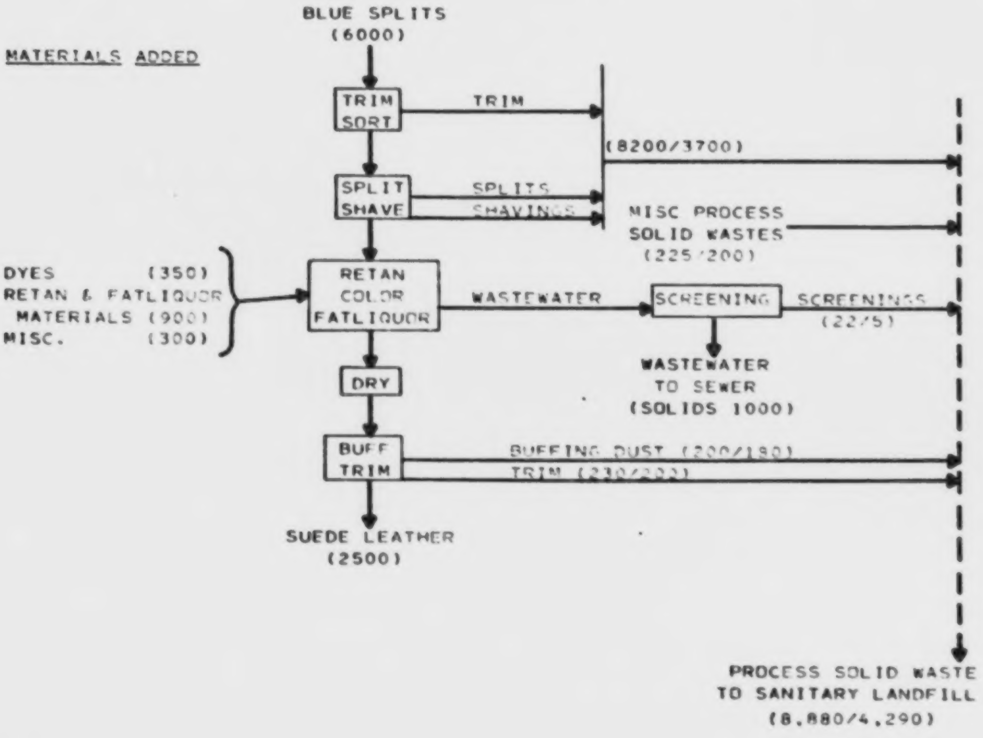
3.6.2 Potentially Hazardous Solid Waste. As indicated in Figure 8, several kinds of solid waste is generated. The potentially hazardous wastestreams are discussed below.

Trimmings, Splits, and Shavings. The initial trimming, resplitting, and shaving operations generate a total of 8,200 (wet)/3,700 (dry) kg of solid waste per 1000 equivalent hides processed at a typical split tannery, which on a nationwide basis amounts to 29,100 (wet)/13,100 (dry) metric tons per year of which 14,300 (wet)/6,460 (dry) is sold as a by-product. Samples were collected from the splitting machines, shaving machines, and trimming department at six tanneries. Analysis of these samples indicated an average chromium concentration of 9,600 (wet)/22,300 (dry) mg/kg, with a range of 10,000 to 28,000 mg/kg on a dry weight basis.

FIGURE 8

PROCESS FLOW DIAGRAM
TYPICAL SPLIT TANNERY

(All units are kg/1000 equivalent hides on a dry weight basis except solid wastes which are given on a wet/dry basis)


BLUE SPLITS
(6000)
MATERIALS ADDED
TRIM
SORT
TRIM
(8200/3700)
SPLIT
SHAVE
SPLITS
SHAVINGS
MISC PROCESS
SOLID WASTES
(225/200)
DYES (350)
RETAN & FATLIQUOR
MATERIALS (900)
MISC. (300)
RETAN
COLOR
FATLIQUOR
WASTEWATER
SCREENING
SCREENINGS
(22/5)
WASTEWATER
TO SEWER
(SOLIDS 1000)
DRY
BUFF
TRIM
BUFFING DUST (200/180)
TRIM (230/200)
SUEDE LEATHER
(2500)
PROCESS SOLID WASTE
TO SANITARY LANDFILL
(8,880/4,290)

Unfinished Leather Trim. Following buffing and before packaging for shipment, suede leather is normally trimmed to remove ragged edges. A typical split tannery generates 230 (wet)/200 (dry) kg of leather trim per 1000 equivalent hides processed, which on a national basis amounts to 810 (wet)/715 (dry) metric tons per year. Samples were collected from fiber drums or self-dumping hoppers in the trimming departments of seven tanneries. Analysis of these samples indicated the presence of the following hazardous constituents:

Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry	Concentration range (mg/kg) Dry
Chromium	19,000	21,000	7,600 - 45,000
Lead	250	280	120 - 460

Buffing Dust. Mechanical sanding of suede leather to remove surface imperfections and to produce a uniform nap generates fine particles of leather which must be disposed of as solid waste. A typical split tannery produces 200 (wet)/180 (dry) kg of buffing dust per 1000 equivalent hides processed, which on a national basis amounts to 715 (wet)/639 (dry) metric tons per year. Samples were taken from the buffing dust collection devices at seven split tanneries. Analysis of these samples indicated the presence of hazardous constituents as follows:

Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry	Concentration range (mg/kg) Dry
Chromium	20,000	22,000	1,200 - 60,000
Lead	71	77	44 - 120

Wastewater Screenings. Most split tanneries screen their wastewater before discharge, and a typical split tannery generates 22 (wet)/5 (dry) kg of screenings per 1000 equivalent hides processed, which on a national basis amounts to 78 (wet)/18 (dry) metric tons per year. Samples were collected from the wastewater screens at seven tanneries. The screenings primarily consist of relatively small pieces of leather which have been torn off the hides during processing. Analysis of these samples indicated the presence of hazardous constituents as follows:

Constituent	Avg. concentration (mg/kg) Wet	Dry	Concentration range (mg/kg) Dry
Chromium	970	4,200	5 - 14,000
Lead	40	175	43 - 190

3.6.3 Non-Hazardous Solid Waste. Miscellaneous process solid waste is generated at a rate of 225 (wet)/200 (dry) kg per 1000 equivalent hides processed, which on a national basis amounts to 700 (wet)/650 (dry) metric tons per year. This waste is composed of fiber drums, paper bags, wooden pallets on which the splits are received, and general plant floor sweepings, and they do not contain constituents at potentially hazardous concentrations.

3.6.4 Factors Affecting Future Solid Waste Generation.

Air Pollution Control. Air pollution control devices are utilized to collect the leather dust which is generated by buffing. Buffing dust is currently being effectively collected at a majority of split tanneries. Installation of adequate and effective collection devices at tanneries not currently utilizing effective collection systems, and retrofit installations of more efficient collection systems which may be required by air pollution control regulations in certain areas, will not increase the quantity of buffing dust destined for land disposal by 1977, but will result in a 10 percent increase by 1983.[23]

Water Pollution Control. The vast majority of split tanneries discharge their wastewater to municipal sewer systems with no treatment other than screening. Since the suspended solids content of the wastewater from a split tannery is relatively low, it is anticipated that split tanneries will not find it cost-effective to install pretreatment facilities. As a result, it is anticipated that screening will continue to be the predominate type of wastewater treatment in 1977 and 1983.

Industry Trends. Since the raw material utilized by the split tanning portion of the leather tanning industry is produced by complete chrome tanneries and retan/finishers, it is anticipated that production from split tanneries will follow the growth rate of the sum of the retan/finish and complete chrome tannery operations. Thus, it is assumed that the growth rate for split tannery production will be 2.6 percent per year through 1983.[2]

3.6.5 Typical Plant Waste Summary. The current (1974) and projected (1977 and 1983) generation factors for process solid waste and the various types and quantities of potentially hazardous solid waste generated by a typical split tannery are summarized in Table 26. As the table indicates, the generation factors for a typical split tannery are not expected to change appreciably in the future.

3.6.6 EPA Region and National Waste Summary. Table 27 presents the total quantity of process solid waste and the types and quantities of hazardous constituents, currently (1974) generated by split tanneries. Quantities projected for 1977 and 1983 are presented in Tables 28 and 29, respectively. As indicated by the tables, the vast majority of total process and potentially hazardous solid waste generated by split tanneries is Region I. This is in large part due to the fact that trimmings, splits, and shavings comprise the vast majority of both total process and potentially hazardous solid waste, and this type of waste is currently sold as a by-product in Region V; however, there is no market for these wastes in Region I.

3.7 Leather Finishers

3.7.1 Plant Operations. Tanneries in this category normally function on a contract basis. Thus, finishers receive unfinished leather from a customer, apply a finish to it, and then return it to the customer, charging a fee for the service. Finishes are normally applied either by hand or in mechanical spray booths and may consist of either water or solvent base preparations. In addition, the leather is sometimes buffed to remove imperfections in the grain surface or improve the nap of the flesh side. A typical leather finisher processed 225,000 equivalent hides in 1974. Figure 9 summarizes the basic production operations performed, the types and quantities of raw materials and products involved, and the types and quantities of waste products.

3.7.2 Potentially Hazardous Solid Waste. As indicated in Figure 9, three kinds of solid waste is generated. The two potentially hazardous wastestreams are discussed below. The data presented is based upon information collected during visits to three contract finishers and 22 complete chrome tanneries. The information from complete chrome tanneries is included here because the finishing operations performed in complete chrome tanneries and by contract finishers are essentially the same. However, contractor finishers do not have screens or other treatment works.

TABLE 26

WASTE GENERATION FACTORS FOR A TYPICAL SPLIT TANNERY
(All units are kg per 1000 equivalent hides)

Waste Type		1974 & 1977* Wet	1974 & 1977* Dry	1983 Wet	1983 Dry
Total Process Solid Waste		8,880	4,290	8,900	4,310
Total Potentially Hazardous Solid Waste		8,650	4,000	8,670	4,110
Trimmings & Shavings	Total	8,200	3,700	8,200	3,700
	Cr	---	78.7	---	78.7
Unfinished Leather Trim	Total	230	200	230	200
	Cr	---	4.37	---	4.37
	Pb	---	0.058	---	0.058
Buffing Dust	Total	200	180	220	200
	Cr	---	4.0	---	4.4
	Pb	---	0.014	---	0.015
Wastewater Screenings	Total	22	5	22	5
	Cr	---	0.021	---	0.021
	Pb	---	0.009	---	0.009

Source: SCS Engineers

* No processing changes are expected between 1974 and 1977 that would change the generation factors. Thus they are identical.

TABLE 27

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE GENERATED IN 1974 BY SPLIT TANNERIES

(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste.		Trimmings, splits & shavings*			Unfinished leather trimmings			
						Total Potentially Hazardous		Constituent	Total Potentially Hazardous		Constituents	
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Wet	Dry	Chromium	Lead
I	MA,NH	14500	7100	14100	6700	13300	6000	130	370	330	7.10	0.10
V & IX	WI,IL,CA	2200	1450	1900	1200	1000	460	10	440	385	8.41	0.11
TOTAL		16700	8550	16000	7900	14300	6460	140	810	715	15.51	0.21

EPA Region(s)	State(s)	Buffing dust				Wastewater screenings			
		Total Potentially Hazardous		Constituents		Total Potentially Hazardous		Constituents	
		Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead
I	MA,NH	330	290	6.5	0.02	36	8	0.030	.0014
V & IX	WI,IL,CA	385	350	7.7	0.03	42	10	0.041	.0017
TOTAL		715	639	14.2	0.05	78	18	0.071	.0031

Source: SCS Engineers

* Estimates reflect that this waste is sold in some areas.

TABLE 28

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTES ANTICIPATED TO BE GENERATED IN 1977 BY SPLIT TANNERIES
(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Trimmings, splits & shavings*			Unfinished leather trimmings			
						Total Potentially Hazardous		Constituent	Total Potentially Hazardous		Constituents	
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Wet	Dry	Chromium	Lead
I	MA,NH	15600	7630	15200	7270	14400	6500	138	400	350	7.7	0.10
V & IX	WI,IL,CA	2520	2470	2050	1300	1110	500	11	480	415	9.1	0.12
TOTAL		18100	10100	17250	8570	15500	7000	149	880	765	16.8	0.22

EPA Region(s)	State(s)	Buffing dust				Wastewater screenings			
		Total Potentially Hazardous		Constituents		Total Potentially Hazardous		Constituents	
		Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead
I	MA,NH	350	315	7.0	0.025	39	9	0.037	.0015
V & IX	WI,IL,CA	415	375	8.3	0.031	46	10	0.044	.0018
TOTAL		765	690	15.3	0.056	85	19	0.081	.0033

Source: SCS Engineers

* Estimates reflect that this waste is sold in some areas.

TABLE 29

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE ANTICIPATED TO BE GENERATED IN 1983 BY SPLIT TANNERIES
(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Trimmings, splits & shavings*			Unfinished leather trimmings			
						Total Potentially Hazardous		Constituent	Total Potentially Hazardous		Constituents	
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Wet	Dry	Chromium	Lead
I	MA,NH	18200	8800	17700	8400	16800	7560	160	470	410	8.94	0.12
V & IX	WI,IL,CA	2950	2060	2400	1580	1290	580	12	560	480	10.6	0.14
TOTAL		21150	10860	20100	9980	18090	8140	172	1030	890	19.5	0.26

EPA Region(s)	State(s)	Buffing dust				Wastewater screenings			
		Total Potentially Hazardous		Constituents		Total Potentially Hazardous		Constituents	
		Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead
I	MA,NH	440	40.	6.8	0.031	45.5	9.75	0.042	.0018
V & IX	WI,IL,CA	523	470	10.4	0.037	53.8	11.5	0.050	.0021
TOTAL		963	870	17.2	0.068	99.3	21.3	0.092	.0039

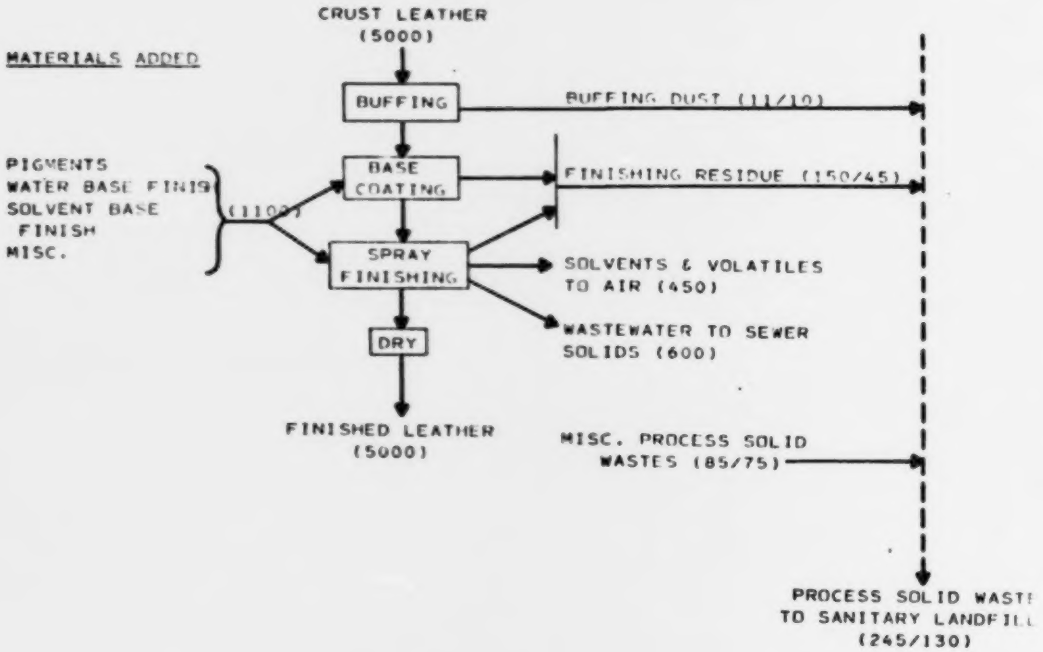
Source: SCS Engineers

* Estimates reflect that this waste is sold in some areas.

FIGURE 9

PROCESS FLOW DIAGRAM
TYPICAL LEATHER FINISHER

(All units are kg/1000 equivalent hides on a dry weight basis except solid wastes which are given on a wet/dry basis)


CRUST LEATHER
(5000)
MATERIALS ADDED
BUFFING
BUFFING DUST (11/10)
PIGMENTS
WATER BASE FINISH
SOLVENT BASE
FINISH
MISC.
(1100)
BASE
COATING
FINISHING RESIDUE (150/45)
SPRAY
FINISHING
SOLVENTS & VOLATILES
TO AIR (450)
WASTEWATER TO SEWER
SOLIDS (600)
DRY
FINISHED LEATHER
(5000)
MISC. PROCESS SOLID
WASTES (85/75)
PROCESS SOLID WASTE
TO SANITARY LANDFILL
(245/130)

Buffing Dust. Buffing dust is produced when the dried and trimmed leather is mechanically sanded to remove surface imperfections or to improve the nap on the flesh side. A typical tannery in this category generates 11 (wet)/10 (dry) kg per 1000 equivalent hides processed, which on a national basis totals 61 (wet)/56 (dry) metric tons per year. Analysis of samples taken from the buffing dust collectors at seven plants showed the presence of the following hazardous constituents:

Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry	Concentration range (mg/kg) Dry
Chromium	20,000	22,000	1,200 - 60,000
Lead	71	77	44 - 120

Finishing Residues. Finishing residues are produced as a result of air pollution control devices on spray booths and from general cleaning of the finishing equipment. A typical finisher generates 150 (wet)/45 (dry) kg per 1000 equivalent hides processed, which totals 832 (wet)/250 (dry) metric tons per year on a national basis. Analysis of samples taken from the finishing area in nine tanneries indicated the presence of the following hazardous constituents:

Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry	Concentration range (mg/kg) Dry
Chromium	525	1,700	<4 - 5,200
Lead	1,100	3,600	<10 - 17,000
Zinc	105	340	(not detected) 1,400

3.7.3 Non-Hazardous Solid Waste.

Miscellaneous process solid waste is generated at a rate of 80 (wet)/74 (dry) kg per 1000 equivalent hides processed, which amounts to 440 (wet)/420 (dry) metric tons per year on a national basis. This waste is composed primarily of fiber drums and general plant floor sweepings, and they do not contain constituents at potentially hazardous concentrations.

3.7.4 Factors Affecting Future Solid Waste Generation.

Air Pollution Control. Air pollution control devices are used to remove particulates from the exhaust gases of spray finishing booths and to collect the buffing dust which is produced by the buffing machines. A finishing operation typically has a water-wash system to remove particulates and aerosols from the finishing spray booth exhaust. It is anticipated that the gradual installation of water-wash collection systems in the very few tanneries which do not currently (1974) utilize them, and retrofit installations of more efficient collection systems which will be required by air pollution regulations in certain areas, will not result in an increase in finishing residues by 1977, but will produce a 5 percent increase by 1983.[23]

Finishers with buffing equipment also are equipped with buffing dust collection devices. Installation of more effective collection devices are anticipated to be required by air quality regulations in certain areas; it is anticipated that this will not result in an increase in finishing residues in 1977, but will produce a 10 percent increase by 1983.[23]

Water Pollution Control. Currently (1974), there is no solid waste generated as a result of wastewater treatment by most finishers. Since the waste load resulting from finishing operations is relatively low, as compared with other tanning operations, it is anticipated that pretreatment of wastewater from finishing plants will not be generally practiced by 1977 or 1983. As a result, water pollution control will not affect the quantity of solid waste destined for land disposal from finishing operations.

Industry Trends. It is projected that there will be a gradual decline in the production of firms engaged in finishing only. This decline is based upon two trends in the industry. The first is the general increased concentration of both leather producing firms and their customers. Second, and most important, is a decline in the amount of crust leather which is being imported for finishing. It is expected that production from firms engaged in finishing will decline at the rate of 3 percent per year through 1983.[2]

3.7.5 Typical Plant Waste Summary. The current (1974) and projected (1977 and 1983) generation factors for process solid waste and the various types and quantities of hazardous solid waste constituents generated by a typical leather finishers are summarized in Table 30 . As indicated in the table, a typical leather finisher currently produces a relatively small quantity of both process and potentially hazardous solid waste per 1000 equivalent hides as compared to other types of tanneries, and this situation is not anticipated to change significantly by 1983.

3.7.6 EPA Region and National Waste Summary. Table 31 presents the total quantity of process solid waste, and the types and quantities of potentially hazardous waste, including their respective hazardous constituents, currently (1974) generated by leather finishers. Quantities projected for 1977 and 1983 are presented in Tables 32 and 33 , respectively.

TABLE 30

WASTE GENERATION FACTORS FOR A TYPICAL LEATHER FINISHER

Waste		1974 & 1977*		1983	
		Wet	Dry	Wet	Dry
Total Process Solid Waste		245	130	255	133
Total Potentially Hazardous Solid Waste		161	55	170	58
Buffing Dust	Total	11	10	12	11
	Cr	---	0.22	---	0.24
	Pb	---	0.0008	---	0.0009
Finishing Residues	Total	150	45	158	47
	Cr	---	0.079	---	0.083
	Zn	---	0.016	---	0.017
	Pb	---	0.17	---	0.18

Source: SCS Engineers

* No processing changes are expected between 1974 and 1977 that would change the generation factors. Thus they are identical.

TABLE 31

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE GENERATED IN 1974 BY LEATHER FINISHERS
(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Buffing dust: Total Potentially Hazardous		Buffing dust: Constituents		Finishing residues: Total Potentially Hazardous		Finishing residues: Constituents		
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Zinc	Lead
I	ME,MA,NH	828	439	544	186	37.2	33.8	0.74	0.0026	507	152	0.27	0.053	0.558
II	NY	159	84.5	105	35.8	7.15	6.5	0.14	0.00051	97.5	29.3	0.051	0.010	0.11
	NJ	207	110	136	46.4	9.27	8.43	0.19	0.00066	126	37.9	0.066	0.013	0.14
III	PA,DE	40.9	21.7	26.9	9.19	1.84	1.67	0.037	0.00013	25.1	7.52	0.013	0.0026	0.028
V	OH,IL,WI	68.6	36.4	45.1	15.4	3.08	2.8	0.062	0.00022	42	12.6	0.022	0.0044	0.046
IV & IX	TN,NC,CA	56.6	30.0	37.2	12.7	2.54	2.31	0.051	0.00018	34.7	10.4	0.018	0.0037	0.038
TOTAL		1360	722	894	305	61.1	55.5	1.22	0.0043	832	250	0.44	0.088	0.92

Source: SCS Engineers

TABLE 32

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE ANTICIPATED TO BE GENERATED IN 1977 BY LEATHER FINISHERS
(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Buffing dust				Finishing residues				
						Total Potentially Hazardous		Constituents		Total Potentially Hazardous		Constituents		
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Zinc	Lead
I	MA,NH	747	397	488	168	33.6	30.5	0.67	0.0024	458	137	0.24	0.048	0.50
II	NY NJ	145 186	76.7 98.8	94.4 122	32.5 41.8	6.49 8.36	5.9 7.6	0.13 0.17	0.00046 0.00059	88.5 114	26.6 34.2	0.047 0.060	0.0093 0.012	0.097 0.13
III	PA,DE	37.0	19.6	24.2	8.31	1.66	1.51	0.033	0.00012	22.7	6.80	0.012	0.0024	0.025
V	OH,IL,WI	61.3	32.5	40.0	13.8	2.75	2.5	0.055	0.00020	37.5	11.3	0.020	0.0040	0.041
IV & IX	TN,NC,CA	51.0	27.0	33.3	11.4	2.29	2.08	0.046	0.00016	31.2	9.36	0.016	0.0033	0.034
TOTAL		1230	652	802	276	55.2	50.1	1.10	0.0039	752	225	0.39	0.079	0.83

Source: SCS Engineers

TABLE 33

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE ANTICIPATED TO BE GENERATED IN 1983 BY LEATHER FINISHERS
(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Buffing dust				Finishing residues				
						Total Potentially Hazardous		Constituents		Total Potentially Hazardous		Constituents		
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Zinc	Lead
I	MA,NH	649	341	433	149	32.1	29.1	0.64	0.0023	412	122	0.22	0.043	0.45
II	NY NJ	125 162	65.7 85.1	83.2 108	28.6 126	6.18 8.01	5.59 7.25	0.12 0.16	0.00044 0.00057	79.3 103	23.4 30.3	0.042 0.054	0.0083 0.010	0.087 0.11
III	PA,DE	32.1	16.9	21.4	7.35	1.59	1.44	0.032	0.00011	20.4	6.01	0.011	0.0021	0.022
V	OH,IL,WI	53.8	28.3	35.8	12.3	2.66	2.41	0.053	0.00019	34.2	10.1	0.018	0.0036	0.038
IV & IX	TN,NC,CA	44.4	23.3	29.6	10.2	2.19	1.99	0.044	0.00016	28.2	8.32	0.015	0.0030	0.031
TOTAL		1070	560	711	333	52.7	47.8	1.05	0.0037	677	200	0.36	0.071	0.74

Source: SCS Engineers

More than one-half of the total process and potentially hazardous solid waste generated by leather finishers are produced in Region I. This situation is not anticipated to change by 1983, although the quantity of total process and potentially hazardous solid waste generated by leather finishers is anticipated to decrease 20 percent by 1983.

3.8 Beamhouse/Tanhouse Facilities

3.8.1 Plant Operations. As shown in Figure 3-7, beamhouse/tanhouse facilities produce chrome tanned "blue stock" (hides which have been chrome tanned but not dried and which are sold to other tanneries for retanning and finishing). The production processes utilized to produce blue stock are essentially identical to those used by complete chrome tanneries to process leather through this stage.

Brine cured, prefleshed cattlehides are the primary raw material. After receipt, the hides are soaked in a water solution in order to return the natural moisture to the hide fibers. Excess fatty substances are removed mechanically after which the hides are treated with lime and sodium sulfide to dissolve the hair. The hides are then treated with an enzyme to loosen the fiber structure and subsequently pickled to reduce the pH and to prepare the fiber for penetration of the tanning materials. The hides are then tanned with a basic chromic sulfate solution, after which they are rung to obtain a product with uniform moisture content. The blue stock is then measured and stacked on pallets which are wrapped in plastic to prevent loss of moisture and shipped to the customer. A typical beamhouse/tanhouse facility processed 300,000 equivalent hides in 1974.[2]

Figure 10 summarizes the basic production operations performed, the types and quantities of raw materials and products involved, and the types and quantities of waste products resulting from the production process.

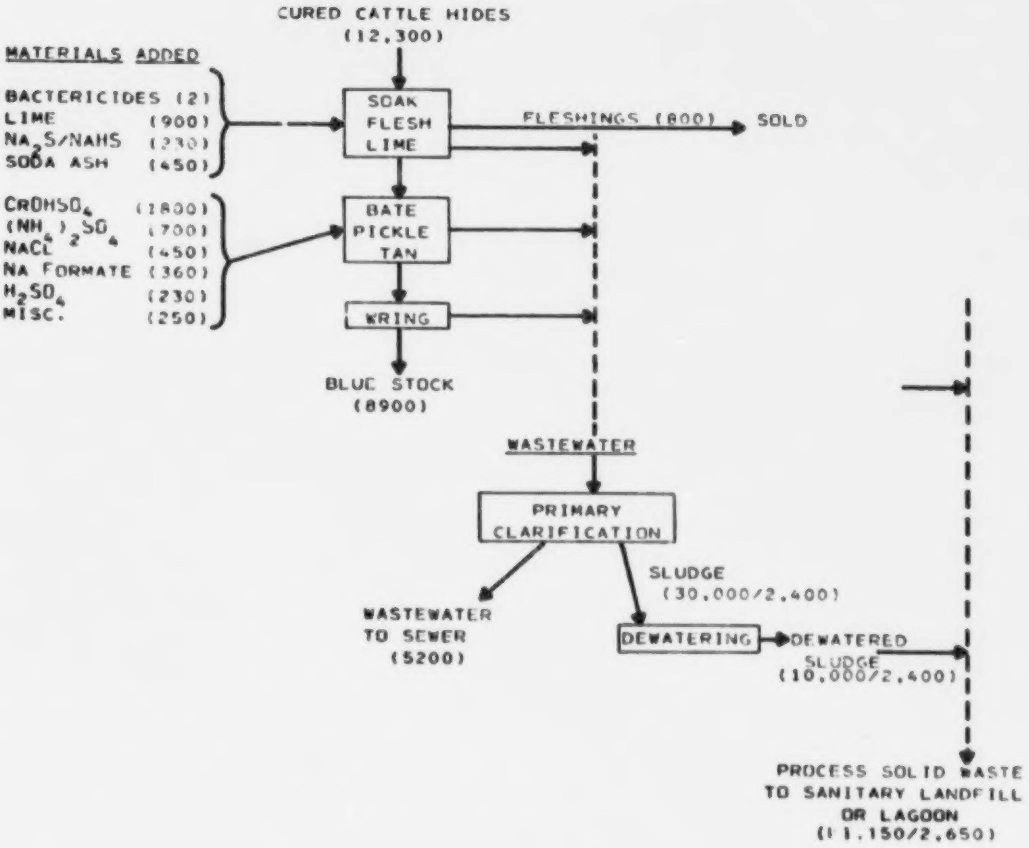
3.8.2 Potentially Hazardous Solid Waste. As indicated in Figure 10, several kinds of solid waste is generated. The only potentially hazardous wastestream is wastewater treatment sludges.

Since the waste load of a beamhouse/tanhouse facility is often more than 20,000 mg/l total solids, a typical tannery of this type provides primary clarifications of its wastewater prior to discharge to municipal sewers. The sludge which is produced by this process is dewatered and disposed of as a solid waste. A typical plant generates 10,000 (wet)/2,400 (dry) kg of dewatered sludge per 1000 equivalent hides processed, which on a national basis amounts to 21,500 (wet)/5,570 (dry) metric tons per year. Analysis of a sample taken from the primary clarifier at one plant indicated the presence of the following hazardous consitutents:

FIGURE 10

PROCESS FLOW DIAGRAM
TYPICAL BEAMHOUSE/TANHOUSE

(All units are kg/1000 equivalent hides on a dry weight basis except solid wastes which are given on a wet/dry basis)


CURED CATTLE HIDES
(12,300)
MATERIALS ADDED
BACTERICIDES (2)
LIME (900)
$NA_2S/NAHS$ (230)
SODA ASH (450)
SOAK
FLESH
LIME
FLESHINGS (800)
SOLD
$CROHSO_4$ (1800)
$(NH_4)_2SO_4$ (700)
NACL (450)
NA FORMATE (360)
H_2SO_4 (230)
MISC. (250)
BATE
PICKLE
TAN
WRING
BLUE STOCK
(8900)
WASTEWATER
PRIMARY
CLARIFICATION
WASTEWATER
TO SEWER
(5200)
SLUDGE
(30,000/2,400)
DEWATERING
DEWATERED
SLUDGE
(10,000/2,400)
PROCESS SOLID WASTE
TO SANITARY LANDFILL
OR LAGOON
(11,150/2,650)

Constituent	Avg. concentration (mg/kg) Wet	 Dry
Chromium	5,100	28,000
Lead	25	140

3.8.3 Non-Hazardous Solid Waste.

Miscellaneous process solid waste is generated at a rate of 250 (wet)/ 225 (dry) kg per 1000 equivalent hides processed, which amounts to 526 (wet)/473 (dry) metric tons per year on a national basis. This waste is composed of fiber drums, paper bags, strings cut off the blades, and general plant floor sweepings, and they do not contain constituents at potentially hazardous concentrations. Fleshings generated by beamhouse/tanhouse facilities are sold; they were therefore, not considered as a solid waste.

3.8.4 Factors Affecting Future Solid Waste Generation.

Air Pollution Control. Air pollution control devices are not currently (1974) used by beamhouse/tanhouse facilities, since spray finishing and buffing operations are not performed. It is anticipated that this situation will remain unchanged through 1977 and 1983.

Water Pollution Control. Primary clarification is currently (1974) utilized by virtually all beamhouse/tanhouse facilities to reduce the solids content of their wastewater prior to discharge to a municipal treatment system, and it is anticipated that this will continue to be the predominant level of treatment through 1983. As new beamhouse/tanhouse facilities are established, it is anticipated that by 1983 an estimated 15 to 20 percent additional waste per 1000 equivalent hides processed will be disposed to the land. either in the form of sludge from primary (and possibly secondary) treatment facilities or by evaporation lagoons or other land disposal means.

Information collected during this study indicates that the quantities of chemicals used to perform specific operations (i.e., tanning) vary considerably from one plant to another. This variation is in part a result of successful efforts at some tanneries to conserve chemicals. It is anticipated that as the price of chemicals continues to increase, more tanneries will reduce chemical usage, and new tanneries will be planned so as to use less chemicals.

As a result of reducing chemical usage, the solids content of the wastewater can be expected to decrease. Consequently, less sludge will be generated as a result of primary treatment of wastewater. It is anticipated that by

1983, chemical conservation techniques will reduce the quantity of sludge generated per 1000 equivalent hides processed by 15 to 20 percent. Overall it is expected that on a dry weight basis per 1000 equivalent hides processed, the reduced quantity of sludge generated due to conservation of chemicals will approximately equal the increased quantity of waste destined for land disposal due to increased treatment facility removal efficiencies and land treatment.

Industry Trends. Current industry opinion is that beamhouse/tanhouse facility production will grow at a rate of 8 percent per year, as a result of several considerations.[2] First, the large beamhouse/tanhouse facilities observed had more efficient operations than smaller complete chrome tanneries. Secondly, it is anticipated that many of these beamhouse/tanhouse facilities will be located close to the source of the cattlehides (the West and Midwest) in order to reduce shipping costs. Also, complete chrome tanneries currently located in cities with increasingly stringent pretreatment requirements were discussing the feasibility of moving the beamhouse/tanhouse part of their operations to other locations, while maintaining the retan and finishing operations in their current location.

3.8.5 Typical Plant Waste Summary. The current (1974) and projected (1977 and 1983) generation factors for process solid waste and the various types of potentially hazardous solid waste are tabulated below. These factors are in units of kg per 1000 equivalent hides. No change in these generation factors is anticipated through 1983.

	Wet	Dry
Total process solid waste	10,250	2,630
Total potentially hazardous solid waste--dewatered primary treatment sludges	10,000	2,400
Chromium		51
Lead		0.25

3.8.6 EPA Region and National Waste Summary. Table 34 presents the total quantity of process solid waste, and the types and quantities of potentially hazardous waste, including their respective hazardous constituents, currently (1974) produced by beamhouse/tanhouse facilities. Quantities projected for 1977 and 1983 are presented in Tables 35 and 36, respectively. As these tables indicate, the quantity of process and potentially hazardous solid waste generated by beamhouse/tanhouse facilities is expected to increase by 26 percent by 1977 and 100 percent by 1983. This increase

TABLE 34

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE GENERATED IN 1974 BY BEAMHOUSE/TANHOUSE FACILITIES
(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Wastewater sludge			
						Total Potentially Hazardous		Constituents	
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Lead
I, II, VI & IX	MA, NJ AZ, TX	4210	1090	4110	986	4110	986	21.0	0.10
V & VIII	MN, WI, CO	6310	1630	6160	1480	6160	1480	31.4	0.15
VII	IA, MO	11000	2850	10800	2580	10800	2580	54.9	0.27
TOTAL		21500	5570	21100	5050	21100	5050	107	0.53

Source: SCS Engineers

TABLE 35

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE ANTICIPATED TO BE GENERATED IN 1977 BY BEAMHOUSE/TANHOUSE FACILITIES

(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Wastewater sludge			
						Total Potentially Hazardous		Constituents	
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Lead
I,II,VI & IX	MA,NJ AZ,TX	5300	1370	5170	1240	5170	1240	26.3	0.13
V & VIII	MN,WI, CO	7940	2050	7750	1860	7750	1860	39.4	0.19
VII	IA,MO	13900	3590	13500	3250	13500	3250	68.9	0.34
TOTAL		27100	7010	26400	6350	26400	6350	135	0.66

Source: SCS Engineers

TABLE 36

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE ANTICIPATED TO BE GENERATED IN 1983 BY BEAMHOUSE/TANHOUSE FACILITIES

(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Wastewater sludge			
						Total Potentially Hazardous		Constituents	
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Lead
I,II,VI & IX	MA,NJ AZ,TX	8410	2170	8200	1970	8200	1970	41.9	0.21
V & VIII	MN,WI, CO	12600	3260	12300	2950	12300	2950	62.8	0.31
VII	IA,MO	22000	5700	21500	5160	21500	5160	110	0.54
TOTAL		43000	11100	42000	10100	42000	10100	215	1.06

Source: SCS Engineers

is anticipated primarily as a result of increased production by beamhouse/tanhouse facilities, and is expected to occur in Western and Midwestern states.

3.9 Retan/Finishers

3.9.1 Plant Operations. The retan/finish portion of industry includes those plants which purchase blue stock from beamhouse/tanhouse facilities and process it into finished leather. The basic processes utilized, as shown in Figure 11 are essentially identical to those used in the later stages of the production process at a complete chrome tannery.

A retan/finisher receives blue stock on pallets wrapped in plastic. After unpacking, it is normally sorted by thickness and then split to a uniform thickness. Next, it is shaved to obtain the exact thickness desired and retanned with chrome, vegetable, and/or synthetic tanning materials. Following retanning, the hides are colored and fatliquored. The hides are stretched on a metal frame, pasted on large plates, or hung on racks and dried. The resulting leather is trimmed, physically conditioned to soften the leather, and buffed to smooth the grain surface or the flesh side. At this point, the leather is ready for finishing with a water or solvent base preparation which is used to improve wear and appearance. Following finishing, the leather is trimmed, measured, and then packaged for shipment. A typical retan/finisher processed 675,000 equivalent hides in 1974.[2]

Figure 11 also indicates the basic production operations performed, the types and quantities of raw materials and products involved, and the types and quantities of waste products resulting from the production process.

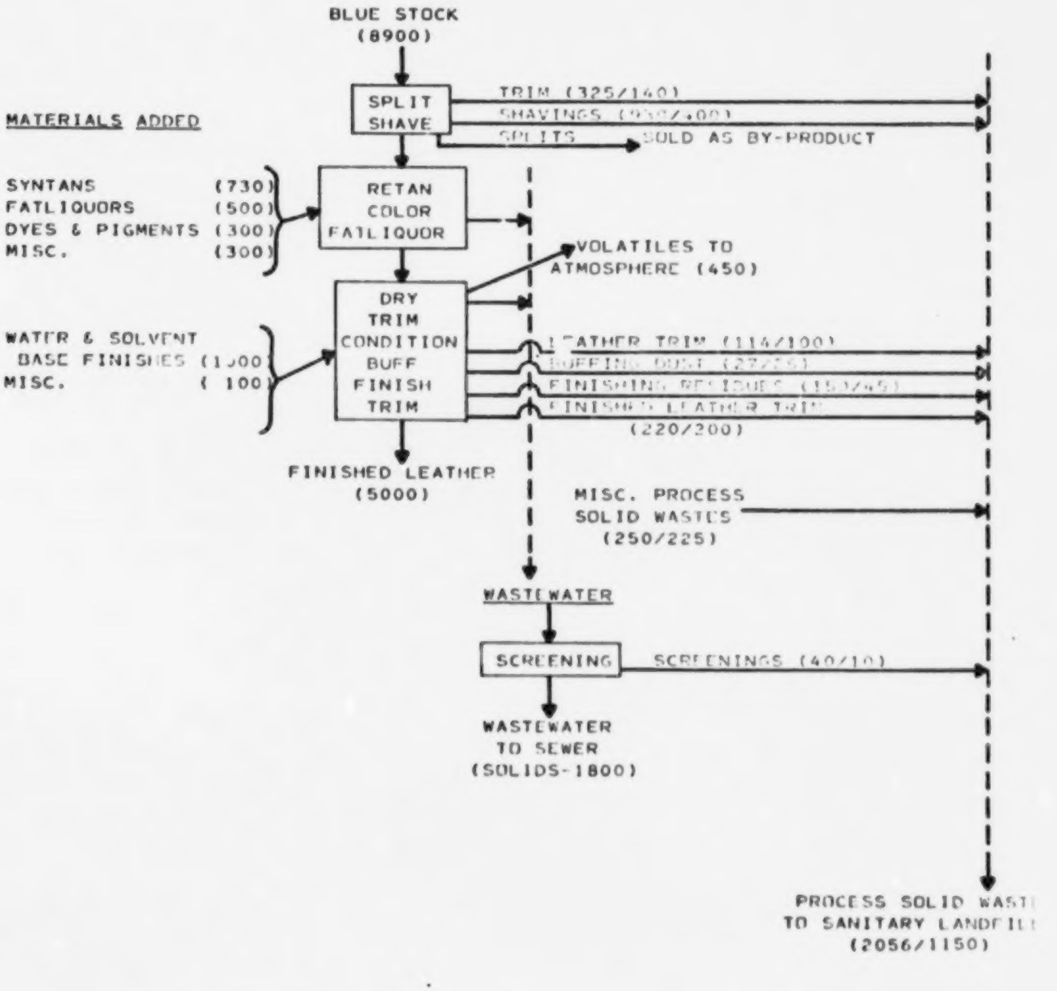
3.9.2 Potentially Hazardous Solid Waste. As indicated in Figure 11, eight kinds of solid waste is generated by retan/finishers. The potentially hazardous wastestreams are discussed below.

Blue Trimmings and Shavings. Blue trimmings and shavings are generated when tanned hides are split and shaved to obtain leather of a uniform thickness. A typical retan/finisher generated 325 (wet)/140 (dry) kg of trimmings per 1000 equivalent hides processed and 930 (wet)/400 (dry) kg of shavings per 1000 equivalent hides processed, which on a national basis totals 3,100 (wet)/1,300 (dry) metric tons per year. Samples were collected from the shavings machines and fiber drums in the trimming departments of six plants. Analysis of these samples indicated that these wastes have an average chromium concentration of 9,600 (wet)/22,300 (dry) mg/kg, with a range of 10,000 to 28,000 mg/kg of a dry weight basis.

FIGURE 11

PROCESS FLOW DIAGRAM
TYPICAL RETAN/FINISHER

(All units are kg/1000 equivalent hides on a dry weight basis except solid wastes which are given on a wet/dry basis)


BLUE STOCK
(8900)
SPLIT
SHAVE
TRIM (325/140)
SHAVINGS (930/400)
SPLITS
SOLD AS BY-PRODUCT
MATERIALS ADDED
SYNTANS (730)
FATLIQUORS (500)
DYES & PIGMENTS (300)
MISC. (300)
RETAN
COLOR
FATLIQUOR
VOLATILES TO
ATMOSPHERE (450)
WATER & SOLVENT
BASE FINISHES (1000)
MISC. (100)
DRY
TRIM
CONDITION
BUFF
FINISH
TRIM
LEATHER TRIM (114/100)
BUFFING DUST (27/25)
FINISHING RESIDUES (150/45)
FINISHED LEATHER TRIM
(220/200)
FINISHED LEATHER
(5000)
MISC. PROCESS
SOLID WASTES
(250/225)
WASTEWATER
SCREENING
SCREENINGS (40/10)
WASTEWATER
TO SEWER
(SOLIDS-1800)
PROCESS SOLID WAST
TO SANITARY LANDFIL
(2056/1150)

Unfinished Leather Trim. Following drying and before finishing, the sides of leather are normally trimmed to remove ragged edges which would otherwise interfere with the finishing process. The average rate of generation of this material is 114 (wet)/100 (dry) kg per 1000 equivalent hides, which on a national basis totals 380 (wet)/246 (dry) metric tons per year. Analysis of samples collected from the trimming departments of seven plants indicated the presence of the following hazardous constituents:

Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry	Concentration range (mg/kg) Dry
Chromium	15,000	17,000	3,600 - 42,000
Lead	110	130	3 - 530

Buffing Dust. Buffing dust is produced when the dried and trimmed leather is mechanically sanded to remove surface imperfections and/or to improve the nap of the fleshed side of the leather. A typical tannery in this category generates 27 (wet)/25 (dry) kg per 1000 equivalent hides, which on a national basis totals 66 (wet)/61 (dry) metric tons per year. Analysis of samples taken from the buffing dust collectors at seven plants indicated the presence of the following hazardous constituents:

Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry	Concentration range (mg/kg) Dry
Chromium	20,000	22,000	1,200 - 60,000
Lead	71	77	44 - 120

Finished Leather Trim. The final operation performed before packaging the finished leather for shipment is trimming. A typical plant produces 220 (wet)/220 (dry) kg per 1000 equivalent hides processed, which on a national basis totals 541 (wet)/492 (dry) metric tons per year. Analysis of samples collected from the trimming and shipping departments of three plants indicated the presence of the following hazardous constituents:

Constituent	Avg. concentration (mg/kg) Wet	Avg. concentration (mg/kg) Dry	Concentration range (mg/kg) Dry
Chromium	19,100	21,200	7,600 - 45,000
Lead	250	280	120 - 460

Finishing Residues. Finishing residues are produced as a result of air pollution control devices on spray finishing booths and from general cleaning of the finishing equipment. A typical retan/finisher generates 150 (wet)/45 (dry) kg per 1000 equivalent hides processed, which totals 369 (wet)/ 111 (dry) metric tons per year on a national basis. Analysis of samples taken from the finishing area in nine plants indicated the presence of the following hazardous constituents:

	Avg. concentration (mg/kg)		Concentration range (mg/kg)
Constituent	Wet	Dry	Dry
Chromium	525	1,700	<4 - 5,200
Lead	1,100	3,600	<10 - 17,000
Zinc	105	340	(Not detected) - 1,400

Wastewater Screenings. Retan/finishers normally screen their wastewater. A typical plant produces 40 (wet)/10 (dry) kg per 1000 equivalent hides processed, which on a national basis totals 98 (wet)/25 (dry) metric tons per year. Analysis of samples collected from the wastewater screens in seven plants indicated the presence of the following hazardous constituents:

	Avg. concentration (mg/kg)		Concentration range (mg/kg)
Constituent	Wet	Dry	Dry
Chromium	965	4,200	5 - 14,000
Lead	40	176	43 - 190

3.9.3 Non-Hazardous Solid Waste. Miscellaneous process solid waste is generated at a rate of 250 (wet)/ 225 (dry) kg per 1000 equivalent hides processed, which amounts to 525 (wet)/470 (dry) metric tons per year on a national basis. This waste is composed of fiber drums, paper bags, and general floor sweepings, and they do not contain constituents at potentially hazardous concentrations.

3.9.4 Factors Affecting Future Solid Waste Generation.

Air Pollution Control. Air pollution control devices are used to remove particulates produced by the spray finishing process and to collect buffing dust. The retan/ finisher typically has a water-wash system to remove particulates from the finishing spray booth exhaust. The particulates removed are currently a relatively minor source of solid waste. It is anticipated that gradual installation of water-wash collection systems in the few tanneries which do not currently (1974) utilize them, and retrofit installation of more efficient collection systems which will be required by air pollution control regulations in certain areas, will not result in a significant increase in finishing residues by 1977, but will produce a 5 percent increase by 1983.[23]

Buffing dust is currently being effectively collected at a majority of retan/finishers. Installation of adequate and effective collection devices at tanneries not currently utilizing effective collection systems will not increase the quantity of buffing dust destined for land disposal by 1977, but will result in a 10 percent increase by 1983.[23]

Water Pollution Control. Screenings are the only type of potentially hazardous solid waste currently generated by retan/finishers as a result of wastewater treatment. Since Federal effluent limitation guidelines for tanneries are currently under litigation, no changes in solid waste generation as a result of wastewater treatment are expected by 1977. However, it is anticipated that by 1983, 25 percent of the retan/finishers will utilize primary pretreatment to remove wastewater solids. It is estimated that this will result in 1000 (wet)/100 (dry) kg of sludge per 1000 equivalent hides processed, which on a national basis will total 810 (wet)/81 (dry) metric tons per year.

Industry Trends. The growth in the retan/finish portion of the leather industry will basically parallel the growth in the beamhouse/tanhouse portion of the industry, except that a portion of the blue stock produced by the beamhouse/tanhouse facilities will be exported. As a result, the growth in the retan/finisher category is projected at 5 percent per year through 1983, compared to the 8 percent per year projected increased for beamhouse/tanhouse facilities.[2]

3.9.5 Typical Plant Waste Summary. The current (1974) and projected (1977 and 1983) generation factors for total process solid waste and the various types and quantities of potentially hazardous solid waste generated by a typical retan/finisher are summarized in Table 37 . The increase in potentially hazardous solid waste anticipated for 1983 is primarily the result of the installation of sewer sumps by a typical retan/finisher to remove wastewater solids.

3.9.6 EPA Region and National Waste Summary. Table 38 presents the total quantity of process solid waste and the types and quantities of potentially hazardous waste, including their respective hazardous constituents, currently (1974) produced by retan/finishers. Quantities projected for 1977 and 1983 are presented in Tables 39 and 40, respectively.

TABLE 37

WASTE GENERATION FACTORS FOR A TYPICAL RETAN/FINISHER
(All units are kg per 1000 equivalent hides)

		1974 & 1977*		1983	
Waste Type		Wet	Dry	Wet	Dry
Total Process Solid Waste		2,060	1,150	2,320	1,180
Total Potentially Hazardous Solid Waste		1,810	920	2,070	950
Trimmings & Shavings	Total	1,260	540	1,260	540
	Cr	---	12.1	---	12.1
Unfinished Leather Trim	Total	114	100	114	100
	Cr	---	1.71	---	1.71
	Pb	---	0.31	---	0.31
Buffing Dust	Total	27	25	30	28
	Cr	---	0.54	---	0.59
	Pb	---	0.0018	---	0.002
Finished Leather Trim	Total	220	200	220	200
	Cr	--	4.2	---	4.2
	Pb	---	0.055	---	0.055
Finishing Residues	Total	150	45	158	47
	Cr	---	0.079	---	0.08
	Pb	---	0.17	---	0.18
	Zn	---	0.016	---	0.017
Wastewater Screenings	Total	40	10	40	10
	Cr	---	0.039	---	0.039
	Pb	---	0.0016	---	0.0016
Wastewater Sludge (from sewer sump)	Total	---	---	1000	100
	Cr	---	---	---	0.68
	Cu	---	---	---	0.05
	Pb	---	---	---	0.006

Source: SCS Engineers

* No processing changes are expected between 1974 and 1977 that would change the generation factors. Thus they are identical.

TABLE 38

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE
GENERATED IN 1974 BY RETAN/FINISHERS
(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Trim and shavings			Unfinished leather trimmings			
						Total Potentially Hazardous		Constituent	Total Potentially Hazardous		Constituents	
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Wet	Dry	Chromium	Lead
I	MA,NH,ME	2320	1290	2040	1040	1420	608	13.6	128	113	1.93	0.14
II	NY	1360	756	1190	607	832	356	7.99	75.2	66	1.13	0.083
	NJ	185	103	153	82.8	113	48.6	1.09	10.3	9	0.15	0.011
III	PA	309	172	272	138	189	81.0	1.82	17.1	15	0.26	0.019
IV,V&IX	TN,WI,CA	892	496	784	398	546	234	5.24	49.4	43	0.74	0.054
TOTAL		5070	2820	4450	2270	1100	1330	29.7	380	246	4.21	0.31

EPA Region(s)	State(s)	Finishing residues					Wastewater screenings			
		Total Potentially Hazardous		Constituents			Total Potentially Hazardous		Constituents	
		Wet	Dry	Chromium	Lead	Zinc	Wet	Dry	Chromium	Lead
I	MA,NH,ME	169	50.7	0.089	0.19	0.018	45	11.3	0.044	0.0018
II	NY	99	29.7	0.052	0.11	0.010	26.4	6.60	0.026	0.0011
	NJ	13.5	4.05	0.0071	0.015	0.0014	3.6	.90	0.0035	0.00014
III	PA	22.5	6.75	0.012	0.035	0.0024	6.0	1.50	0.0058	0.00024
IV,V&IX	TN,WI,CA	65.0	19.5	0.034	0.071	0.0068	17.3	4.33	0.017	0.00069
TOTAL		369	111	0.19	0.41	0.039	98.3	24.6	0.096	0.0039

TABLE 38
(Continued)

EPA Region(s)	State(s)	Buffing dust: Total Potentially Hazardous		Buffing dust: Constituents		Finished leather trim: Total Potentially Hazardous		Finished leather trim: Constituents	
		Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead
I	MA,NH,ME	30.4	28.2	0.61	0.0020	248	225	4.73	0.062
II	NY	17.8	16.5	0.36	0.0012	145	132	2.77	0.036
	NJ	2.43	2.25	0.049	0.00016	19.8	18.0	0.38	0.0050
III	PA	4.05	3.75	0.081	0.00027	33	30.0	0.63	0.0083
IV,VI&IX	TN,WI,CA	11.7	10.8	0.23	0.00077	95.3	86.6	1.82	0.024
TOTAL		66.2	61.5	1.33	0.0044	541	492	10.0	0.135

Source: SCS Engineers

TABLE 39

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE ANTICIPATED TO BE GENERATED IN 1977 BY RETAN/FINISHERS
(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Trim and shavings			Unfinished leather trimmings			
						Total Potentially Hazardous		Constituent	Total Potentially Hazardous		Constituents	
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Wet	Dry	Chromium	Lead
I	MA,NH,ME	2680	1490	2350	1200	1640	702	15.7	148	130	2.22	0.163
II	NY	1570	875	1380	703	963	413	9.24	87.1	76.4	1.31	0.096
	NJ	214	119	188	95.7	131	56.2	1.26	11.9	10.4	0.178	0.013
III	PA	358	199	315	160	219	94.0	2.11	19.8	17.4	0.298	0.022
IV,V&IX	TN,WI,CA	1030	574	907	461	631	271	6.06	57.1	50.1	0.857	0.063
TOTAL		5850	3260	5140	2620	3580	1540	34.4	324	284	4.86	0.36

EPA Region(s)	State(s)	Finishing residues					Wastewater screenings			
		Total Potentially Hazardous		Constituents			Total Potentially Hazardous		Constituents	
		Wet	Dry	Chromium	Lead	Zinc	Wet	Dry	Chromium	Lead
I	MA,NH,ME	195	59	0.10	0.2	0.021	52.0	13.0	0.050	0.0021
II	NY	115	34.4	0.060	0.13	0.012	30.6	7.64	0.030	0.0012
	NJ	15.6	4.68	0.0082	0.017	0.0016	4.16	1.04	0.0040	0.00017
III	PA	26.1	7.83	0.014	0.029	0.0028	6.96	1.74	0.0067	0.00028
IV,V,IX	TN,WI,CA	75.2	22.5	0.040	0.083	0.0075	20.0	5.01	0.019	0.00080
TOTAL		427	128	0.22	0.46	0.045	114	28.4	0.11	0.0046

TABLE 39
(Continued)

EPA Region(s)	State(s)	Buffing dust				Finished leather trim			
		Total Potentially Hazardous		Constituents		Total Potentially Hazardous			
		Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead
I	MA,NH,ME	35.0	33.0	0.70	0.0023	286	260	5.46	0.072
II	NY	20.6	19.1	0.41	0.0014	168	153	3.21	0.042
	NJ	2.81	2.6	0.056	0.00019	22.9	20.8	0.44	0.0057
III	PA	4.70	4.35	0.094	0.00031	38.3	34.8	0.73	0.0096
IV,V&IX	TN,WI,CA	13.5	12.5	0.27	0.00089	110	100	2.10	0.028
TOTAL		76.6	71.6	1.53	0.0050	625	569	11.9	0.16

Source: SCS Engineers

TABLE 40

TOTAL PROCESS AND POTENTIALLY HAZARDOUS WASTE ANTICIPATED TO BE GENERATED IN 1983 BY RETAN/FINISHERS

(metric tons per year, wet and dry basis)

EPA Region(s)	State(s)	Total Process Solid Waste		Total Potentially Hazardous Waste		Trim and shavings Total Potentially Hazardous		Trim and shavings Constituent	Unfinished leather trimmings Total Potentially Hazardous		Unfinished leather trimmings Constituents	
		Wet	Dry	Wet	Dry	Wet	Dry	Chromium	Wet	Dry	Chromium	Lead
I	MA,NH,ME	3910	2040	3470	3470	2210	946	21.2	199	176	3.00	0.22
II	NY	2290	1200	2030	965	1290	554	12.4	117	103	1.76	0.13
	NJ	312	163	277	132	176	75.6	1.69	15.9	14.0	0.24	0.018
III	PA	521	272	462	219	294	126	2.82	26.6	23.4	0.40	0.029
IV,V&IX	TN,WI,CA	1500	785	1330	633	849	364	8.14	76.6	67.5	1.15	0.084
TOTAL		8530	4460	7570	5420	4820	2070	46.3	435	384	6.55	0.48

EPA Region(s)	State(s)	Buffing dust Total Potentially Hazardous		Buffing dust Constituents		Finished leather trim Total Potentially Hazardous		Finished leather trim Constituents	
		Wet	Dry	Chromium	Lead	Wet	Dry	Chromium	Lead
I	MA,NH,ME	50.7	46.2	1.00	0.00332	385	350	7.32	0.097
II	NY	29.7	27.1	0.59	0.0020	226	205	4.29	0.057
	NJ	4.05	3.69	0.080	0.00027	30.8	28.0	0.59	0.0077
III	PA	6.75	6.15	0.13	0.00044	51.3	46.7	0.98	0.013
IV,V&IX	TN,WI,CA	19.5	17.8	0.39	0.0013	148	135	2.81	0.037
TOTAL		111	101	2.19	0.0073	841	765	16.0	0.21

TABLE 40
(Continued)

EPA Region(s)	State(s)	Finishing residues					Wastewater screenings			
		Total Potentially Hazardous		Constituents			Total Potentially Hazardous		Constituents	
		Wet	Dry	Chromium	Lead	Zinc	Wet	Dry	Chromium	Lead
I	MA,NH,ME	271	81.1	0.14	0.30	0.29	74.3	19.1	0.072	0.0029
II	NY	159	47.5	0.084	0.175	0.17	43.6	11.2	0.042	0.0017
	NJ	21.7	6.48	0.011	0.024	0.023	5.94	1.53	0.0058	0.00023
III	PA	36.2	10.8	0.019	0.040	0.038	9.9	2.55	0.010	0.00039
IV,V&IX	TN,WI,CA	104	31.2	0.055	0.12	0.11	28.6	7.36	0.028	0.0011
TOTAL		592	177	0.31	0.65	0.63	168	41.7	0.16	0.0065

EPA Region(s)	State(s)	Wastewater sludge				
		Total Potentially Hazardous		Constituents		
		Wet	Dry	Chromium	Copper	Lead
I	MA,NH,ME	282	28.2	0.76	0.054	0.0071
II	NY	165	16.5	0.45	0.032	0.0042
	NJ	22.5	2.25	0.061	0.0043	0.00057
III	PA	37.5	3.75	0.10	0.0072	0.00095
IV,V&IX	TN,WI,CA	108	10.8	0.29	0.020	0.0027
TOTAL		615	61.5	1.66	0.12	0.016

Source: SCS Engineers

As the tables indicate, the vast majority of retan/finish solid waste is, and will continue to be, generated in four Eastern states. The quantities of waste generated are anticipated to increase 17 percent by 1977 and 69 percent by 1983.

3.10 State and EPA Regional and National Waste Quantities

The quantities of total process and potentially hazardous waste destined for land disposal are listed for 1974, 1977, and 1983 in Tables 41 through 43, respectively. All categories of tanneries are grouped together, and state, EPA Region, and national quantities are shown. The data presented is based on the quantity of solid waste generated at the 41 tanneries visited (in units of kg per equivalent hide processed); the composition of the waste generated, as determined by laboratory analysis (in mg per kg of waste); and industry production data (in units of equivalent hides). Data for states with less than three tanneries has been combined in order to protect the confidentiality of production information.

As shown in Table 41, more tannery process solid waste and potentially hazardous solid waste is generated in Massachusetts than in any other state, followed by Wisconsin and New York. Similarly, approximately one-half of the total process and potentially hazardous solid waste generation occurs in EPA Regions I and V. Minor amounts of solid waste is generated in EPA Regions VI, VIII, and X. In most states, the potentially hazardous solid waste generated represents about 90 to 95 percent of the total process solid waste. Significant exceptions to this pattern occur in states such as Pennsylvania, Georgia, Kentucky, and Virginia, where most or all of the production occurs in vegetable tanneries.

Tables 42 and 43 show the distribution by state of total process and potentially hazardous waste generation projected for 1977 and 1983, respectively. As indicated, waste generation is projected to increase gradually through 1983 in all states except those with a large proportion of vegetable tanneries. This trend is anticipated since production of chrome tanned cattlehides and pigskins is expected to increase, while vegetable tanned and sheepskin leather production is expected to decline.

On a dry weight basis, quantities of total process solid waste will increase 37 percent and potentially hazardous waste by 51 percent by 1983. Industry-wide production is estimated to increase 12 percent by 1983; however, production for the industry segment generating potentially hazardous waste (all tanneries with the exception of vegetable tanneries) will increase 14 percent.[2]

TABLE 41

TOTAL PROCESS AND POTENTIALLY HAZARDOUS SOLID WASTE GENERATED BY ALL TYPES OF TANNERIES IN 1974
(metric tons per year, wet and dry basis)

State(s)	Production (thousands of equivalent hides)	Total Process Solid Waste		Total Potentially Hazardous Wastes		Potentially Hazardous Constituents			
		Wet	Dry	Wet	Dry	Chromium	Zinc	Lead	Copper
AK,WA	28	192	61	177	43	0.96	0.00045	0.015	0.028
AZ,CA	1,870	13,200	4,380	12,200	3,620	73.3	0.027	0.83	1.4[illegible]
CO,UT	221	2,093	562	2,025	496	10.43	0.00092	0.026	0.0[illegible]3
DE	230	649	212	589	162	3.14	0.0037	0.069	0.058
FL,GA	169	1,950	442	61	18	0.32	0.00030	0.0040	0.00[illegible]8
IL	1,630	7,500	2,490	6,900	2,000	40.4	0.017	0.54	1.01
IN,OH	200	1,390	332	184	51	[illegible].96	0.0017	0.027	0.0[illegible]
IA,NE	512	4,690	2,250	4,560	1,100	23.3	0.0014	0.019	0.14
KY	437	5,480	1,210	0	0	0	0	0	0
LA,TX	107	846	227	626	153	3.20	0.00067	0.0079	0.02[illegible]
ME,VT	2,630	13,100	4,430	11,200	3,420	66.9	0.042	1.0	1.64
MD,VA,WV	1,150	14,300	3,180	132	36	0.72	0.00033	0.011	0.021
MA	8,273	31,900	13,000	29,600	11,200	227	0.11	1.97	2.0[illegible]
MI	1,147	7,880	2,490	7,250	1,970	39.5	0.018	0.59	1.1[illegible]
MN	898	6,430	1,980	5,980	1,590	32.1	0.039	0.40	0.[illegible]
MO	774	7,870	2,030	7,380	1,660	35.3	0.00096	0.031	0.[illegible]
NH	1,670	10,1[illegible]	3,370	9,260	2,710	54.0	0.025	0.70	1.2[illegible]
NJ	1,340	3,480	1,130	3,190	885	17.5	0.020	0.[illegible]3	[illegible]
NY	4,020	16,200	5,650	14,600	4,320	63.9	0.065	1.35	1.[illegible]
NC	211	2,420	238	3	1	0.0073	0.00029	0.0030	[illegible]
OR	115	904	262	600	163	3.27	0.0015	0.049	0.04[illegible]
PA	1,860	16,000	4,210	5,570	1,580	31.6	0.017	0.48	0.81
TN	1,230	8,481	2,380	4,620	1,280	25.4	0.015	0.41	0.7[illegible]
WI	4,980	25,[illegible]00	8,500	23,800	6,730	136	0.055	1.66	3.1[illegible]
Total	35,700	203,000	65,000	151,000	45,200	909	0.46	10.6	16.9
Region I	12,600	55,1[illegible]	20,800	50,100	17,300	348	0.18	3.67	4.95
II	5,370	19,700	6,780	17,800	5,220	101	0.085	1.68	[illegible]
III	3,240	31,000	7,600	6,290	1,780	25.5	0.021	0.56	0.9[illegible]
IV	2,040	18,300	4,270	4,680	1,300	25.7	0.016	0.42	0.[illegible]
V	8,[illegible]50	49,100	15,800	44,100	12,300	249	0.13	3.22	6.0[illegible]
VI	107	846	227	626	159	3.2	0.00067	0.0079	0.025
VII	1,290	12,570	4,280	11,900	2,770	[illegible]8.6	0.0023	0.050	0.3[illegible]
VIII	221	2,090	562	2,020	496	10.4	0.00032	0.026	0.09[illegible]
IX	1,870	13,200	4,380	12,200	3,620	73.3	0.027	0.83	1.4[illegible]
X	243	1,100	322	777	211	[illegible].23	0.0020	0.064	0.12

Source: SCS Engineers, except production information which is from Tanners' Council of America

Note: Totals may not add due to rounding.
Production is based on the sum of all hides put into processing at all seven types of tanneries.

TABLE 42

TOTAL PROCESS AND POTENTIALLY HAZARDOUS SOLID WASTE GENERATED BY ALL TYPES OF TANNERIES IN 1977 (PROJECTED)
(metric tons per year, wet and dry basis)

State(s)	Total Process Solid Waste		Total Potentially Hazardous Wastes		Potentially Hazardous Constituents			
	Wet	Dry	Wet	Dry	Chromium	Zinc	Lead	Copper
AK,WA	215	68	220	54	1.07	0.00048	0.016	0.032
AZ,CA	14,900	4,920	13,700	4,100	82.4	0.030	0.96	1.62
CO,UT	2,581	689	2,528	612	12.9	0.00087	0.082	0.58
DE	717	232	625	180	3.44	0.0035	0.070	0.010
FL,GA	1,840	417	68	19	0.33	0.00028	0.0042	0.0086
IL	8,350	2,750	7,440	2,240	44.5	0.018	0.58	1.17
IN,OH	1,340	321	225	56	1.05	0.0016	0.027	0.031
IA,NE	5,840	1,530	5,700	1,380	28.9	0.0013	0.16	0.040
KY	5,150	1,140	0	0	0	0	0	0
LA,TX	908	258	768	188	3.87	0.00062	0.025	0.017
ME,VT	14,400	4,600	12,300	3,610	70.0	0.037	0.98	2.03
MD,VA,WV	13,500	3,000	165	40	0.79	0.00036	0.012	0.024
MA	34,600	14,100	33,900	12,200	246	0.10	2.08	2.88
MI	8,790	2,760	8,040	2,210	43.6	0.020	0.63	1.30
MN	7,320	2,230	7,050	1,820	36.3	0.013	0.46	0.68
MO	9,600	2,470	8,660	2,080	43.9	0.0010	0.24	0.068
NH	11,100	3,700	10,300	3,000	59.2	0.026	0.75	1.48
NJ	3,980	1,280	3,920	1,020	19.9	0.018	0.36	0.34
NY	17,600	6,110	17,000	5,030	91.5	0.065	1.55	2.20
NC	2,280	505	3	1	0.0048	0.00025	0.0027	0
OR	964	281	749	183	3.61	0.0016	0.052	0.11
PA	16,100	4,290	6,860	1,780	34.8	0.18	0.52	0.93
TN	8,850	1,840	5,740	1,430	28.1	0.016	0.44	0.81
WI	29,300	9,550	27,500	7,640	153	0.058	1.90	3.48
Total	220,000	69,100	173,000	51,000	1,000	0.59	11.9	19.6
Region I	60,100	22,450	56,500	18,800	375	0.16	3.81	6.59
II	21,600	7,390	21,400	6,050	111	0.083	1.81	2.64
III	30,300	7,520	7,750	2,000	39.0	0.18	0.60	1.06
IV	18,100	3,900	5,810	1,450	28.4	0.017	0.50	0.82
V	55,100	17,600	50,250	14,000	278	0.11	3.60	6.86
VI	908	258	768	188	3.87	0.00062	0.025	0.017
VII	15,440	4,000	14,400	3,460	72.8	0.0023	0.40	0.11
VIII	2,580	689	2,540	612	12.9	0.00087	0.082	0.058
IX	14,900	4,920	13,700	4,100	82.4	0.030	0.96	1.72
X	1,180	349	969	237	4.68	0.0021	0.068	0.14

Source: SCS Engineers

Note: Totals may not add due to rounding.

TABLE 43

TOTAL PROCESS AND POTENTIALLY HAZARDOUS SOLID WASTE GENERATED BY ALL TYPES OF TANNERIES IN 1983 (PROJECTED)
(metric tons per year, wet and dry basis)

State(s)	Total Process Solid Waste		Total Potentially Hazardous Wastes		Potentially Hazardous Constituents			
	Wet	Dry	Wet	Dry	Chromium	Zinc	Lead	Copper
AK,WA	287	88.8	269	75	1.35	0.00053	.019	0.047
AZ,CA	20,200	6,540	19,100	5,600	107	0.094	1.21	2.39
CO,UT	4,000	1,053	3,890	949	19.7	0.00097	0.12	0.85
DE	973	298	877	243	4.34	0.0035	0.078	0.15
FL,GA	1,750	382	77	22	0.38	0.00027	0.0049	0.012
IL	11,100	3,580	9,670	3,020	55.7	0.020	0.71	1.73
IN,OH	1,344	317	269	75	1.32	0.0016	0.029	0.045
IA,NE	9,130	2,390	8,890	2,140	45.3	0.0012	0.24	0.058
KY	4,870	1,030	0	0	0	0	0	0
LA,TX	1,350	356	1,160	283	5.85	0.00059	0.27	0.023
ME,VT	18,800	5,860	17,500	4,830	37.0	0.039	1.20	2.98
MD,VA,WV	12,800	2,260	200	55	1.00	0.00040	0.014	0.035
MA	43,300	17,100	24,100	15,100	299	0.27	2.38	3.33
MI	11,700	3,640	11,000	3,040	55.1	0.022	0.768	1.92
MN	10,100	3,020	9,550	2,560	48.8	0.015	0.572	1.29
MO	14,600	3,780	13,600	3,270	69.2	0.0011	0.365	0.10
NH	14,500	4,720	13,700	3,980	73.5	0.034	0.91	2.18
NJ	5,570	1,720	5,240	1,440	27.4	0.039	0.41	0.50
NY	22,900	7,690	21,100	6,260	115	0.22	1.76	3.22
NC	2,150	457	2	1	0.0045	0.00023	0.0023	0
OR	1,200	348	912	252	4.56	0.0018	0.064	0.16
PA	17,800	4,770	8,400	2,410	44.1	0.054	0.64	1.37
TN	10,600	3,010	7,010	1,960	35.5	0.026	0.53	1.19
WI	40,100	12,800	37,600	10,600	200	0.093	2.35	5.14
Total	281,000	87,700	214,000	68,200	1,300	0.94	14.7	28.0
Region I	76,600	27,700	55,300	23,900	460	0.34	4.50	8.49
II	28,500	9,410	26,300	7,700	142	0.26	2.17	3.72
III	31,500	7,800	9,480	2,700	49.4	0.056	0.73	1.56
IV	19,400	4,800	7,090	1,980	35.9	0.027	0.54	1.20
V	74,300	23,400	68,100	19,300	361	0.15	4.43	10.1
VI	1,350	356	1,160	283	5.85	0.00059	0.27	0.023
VII	23,700	6,170	22,500	5,410	114	0.0023	0.61	0.16
VIII	4,000	1,060	3,890	950	19.7	0.00097	0.12	0.085
IX	20,200	6,540	19,100	5,600	107	0.094	1.21	2.39
X	1,490	437	1,180	326	5.91	0.0023	0.083	0.21

Source: SCS Engineers

Note: Totals may not add due to rounding.

Thus, part of the increased waste quantities can be attributed to increased production. Much of the remainder of the increase is due to increased generation of wastewater sludge. Complete chrome tanneries will generate 68 percent more sludge in 1983 and sludge from beamhouse/tanhouse facilities will increase 100 percent. No other wastestream in these categories is expected to increase so significantly; most will generate from 10 to 25 percent more waste by 1983. Some wastestreams in the retan/finisher category are projected to increase more than 50 percent; however, their total quantities will not make as significant an impact as the wastewater treatment sludges.

SECTION 4.0

TREATMENT AND DISPOSAL TECHNOLOGY

4.1 Introduction

Essentially all solid wastestreams generated by tanneries using chrome as their tanning medium and those operations limited to leather finishing were characterized in Section 3.0 as being potentially hazardous. In each instance, the wastestream was designated as potentially hazardous on the basis of its heavy metal content. Each of the wastestreams had one or more of the heavy metals--lead, copper, zinc, or trivalent chromium in concentrations greater than the geometric mean concentration found in soils in this country. One wastestream, finishing residues, was characterized as potentially hazardous due to its content of flammable solvents as well as from possible metal toxicity. Unless noted otherwise, all discussion in this section of the report pertains only to potentially hazardous process solid waste.

4.1.1 In-Plant Management. In-plant management of solid waste is similar in most tanneries. Waste is collected at the point of generation and placed (usually by hand) into fiber or steel drums. Periodically the drums are moved to a central loading area where they are unloaded into a tannery or contractor-owned truck for hauling to a disposal site. In some plants, notably split tanneries and some complete chrome tanneries, conveyor or pneumatic systems are used to move large quantities of blue trim and shavings to semi-trailers or roll-off bins located outside the tannery building.

Wastewater treatment sludges accumulated in sewer sumps are normally pumped out periodically into a contractor's truck for disposal. Sludge from primary or secondary wastewater treatment is pumped into tank trucks for hauling. If the sludge is dewatered at the tannery, it is usually collected in lugger containers or conveyed directly to a dump truck.

4.1.2 Collection and Hauling. Of the 41 tanneries visited, 11 hauled their own waste to a disposal site and 30 utilized contractor services. Tanneries which haul their own waste normally own dump trucks which are used for hauling both solid waste and general supplies. Since the waste (with the exception of wastewater treatment residues) is not very dense, dump trucks with oversized bodies are often used. Contract haulers normally use compactor trucks, although roll-off containers, roll-off compactors, or dump trucks are occasionally used.

Preceding page blank

When contract haulers are used, tannery employees normally take the waste from the point of generation to a central pickup point in the tannery yard. When tanneries haul their own waste, the truck picks up the waste at or near the point of generation.

4.1.3 Treatment and Disposal. Treatment of potentially hazardous waste in the leather tanning and finishing industry is restricted to dewatering of wastewater treatment sludges. Most tanneries which employ primary clarification and/or secondary treatment of the wastewater utilize either mechanical or non-mechanical equipment for dewatering the resulting sludges. One tannery visited used gravity thickening of sludge and 10 mechanical dewatering systems (two vacuum filters, four filter presses, and four centrifuges) were observed. The approaches to dewatering, their effectiveness and extent of use are discussed in Section 4.2

Potentially hazardous waste from tanneries is disposed at three types of sites:

- Dumps.
- Landfills.
- Trenches, lagoons, pits, ponds, etc.

The dumps may or may not be burning. They are relatively uncontrolled, are not covered, and little or no attempt is made to protect the environment from their effects.

For purposes of this study, the term landfill includes:

- Sanitary landfills (as defined later).
- Engineered land disposal sites with cover applied less than daily.
- Dumps converted to landfills or non-engineered landfills with cover applied less than daily.

Both publicly and privately owned landfills are utilized by tanneries, and some sites are tannery owned. One landfill visited during the course of the study was state certified to receive hazardous waste.

Trenches, lagoons, and similar depressions are often used for the disposal of potentially hazardous sludges and slurries. They are normally only covered when completely filled. Most sites utilizing this approach to disposal are tannery owned. One trench disposal site visited was state certified to receive tannery waste. It provided protection of the groundwater and groundwater monitoring wells.

Twenty-three disposal sites (serving 113 tanneries) currently receiving tannery waste were visited. Landfilling was the most prevalent type of disposal operation seen, and was the approach used by more tanneries than any other disposal method. Open dumping was noted, especially in New England (EPA Region I) where about 50 percent of tanneries use this disposal mehtod. Only two tanneries disposed of their waste in certified hazardous waste disposal facilities. Further discussion of disposal practices is included in Section 4.3

4.2 Present Treatment Technologies

Most tanneries which employ primary clarification and/or secondary wastewater treatment find it both cost-effective and desirable from the standpoint of disposal to dewater the sludges produced. The water removed is normally returned to the treatment system.

4.2.1 Non-Mechanical Dewatering. One tannery visited utilized sequential settling to increase the solids content of their wastewater treatment sludge prior to disposal. The system consisted of a series of three tanks, following a primary clarifier, in which the sludge is contained during settling. The sludge settles in the first tank, the supernatant from that tank is diverted to the sewer, and the sludge from the first is conveyed to a second tank to settle further, and the process is repeated a third time. The clarifier plus the three settling tanks in series produces a sludge with solids content of approximately 25 percent.

4.2.2 Mechanical Dewatering. Vacuum filter, filter press, or centrifuge dewatering of wastewater treatment sludge was employed by several of the tanneries visited. Vacuum filters with either stainless steel or cloth membranes were seen at two plants. They produced filter cakes of 25 to 30 percent solids. A ferric chloride solution (approximately 10 kg $FeCl_3$ per 1000 kg of sludge at 25 percent solids) and a saturated lime solution (approximately 45 kg lime per 1000 kg of sludge at 25 percent solids) were used as filter aids.

One tannery and three municipal treatment plants (receiving between 80 and 95 percent of their flow from tanneries) were visited which utilize centrifuges to dewater primary or secondary wastewater treatment sludge. One centrifuge was a basket-type, while the others were horizontal decanter centrifuges. Use of a polymer yielded dewatered sludge with about 25 percent solids. More details about the municipal centrifuges and disposal of the solids generated are included in Section 4.4.1.

Two tanneries visited used filter presses to dewater sludge. A typical press has approximately 50 polypropylene cloth--covered plates. Buffing dust is sometimes added as a precoat and filter aid. A 40 to 50 percent solids filter cake is typically produced. The use of buffing dust as a press aid reduces the number of different wastestreams to be handled and stored for disposal. It also improves the efficiency of the filter press, reducing the overall quantity of waste requiring disposal.

4.3 Present Disposal Technologies

The 23 disposal sites visited during the course of the study are characterized below with regard to operation and ownership. The individual entries do not add to 23 since most of the landfill sites also included trenches for sludge.

Operation

Method of disposal	Number visited	Number of tanneries served
Dump	5	11
Landfill*	15	99
Trenches, etc.*	9	25
Agricultural spreading	1	1

* One of which was state certified to receive hazardous waste. These were not collocated.

Ownership

Owner	Number visited	Number of tanneries served
Public	8	52
Tannery	5	5
Other private	10	56

4.3.1 Open Dumping. Open dumping of all types of potentially hazardous waste into dumps and other uncontrolled disposal areas is still a significant practice. Five dumps receiving potentially hazardous waste from 11 tanneries were visited; four were publicly owned; and one was owned by a tannery. Leather trimmings, blue trim and shavings, buffing dust, finishing residues and wastewater screenings were all disposed at four of these dumps. Dewatered wastewater treatment sludge was disposed at one of the sites, and one dump received only finishing residues. Expanded to the industry, it is estimated that 25 percent of the potentially hazardous tannery solid waste was open dumped in 1974. It is estimated that 90 percent of the dumps are publicly owned, 5 percent are privately owned and 5 percent are owned by tanneries.

Most state and local officials and tanneries contacted recognize the environmental inadequacy of open dumping as a disposal method. Municipalities and tanneries commonly cited economic considerations and lack of information on adequate disposal methods as the reasons for the continued use of open dumping. Due to the general awareness of the environmental inadequacy of open dumping, it is anticipated that this practice will be virtually eliminated by 1983.

4.3.2 Landfilling. Approximately 60 percent of potentially hazardous waste is disposed in landfills. A sanitary landfill may be defined as "a land disposal site employing an engineered method of disposing of solid waste on land in a manner that minimizes environmental hazards by spreading the solid waste in thin layers, compacting the solid waste to the smallest practical volume, and applying cover material at the end of each operating day."[24] Approximately 10 percent of the landfills currently (1974) utilized by tanneries for potentially hazardous waste disposal are "sanitary." An additional 25 percent of the landfills used are engineered disposal sites but do not provide daily cover. The remaining landfills are mostly dumps which have been converted to landfills without being engineered.

This study identified 15 landfills which accept potentially hazardous waste from a total of 99 tanneries. The ownership of these landfills is summarized as follows:

Type of operation	Number	Number of tanneries served
Public	4	42
Tannery owned	4	4
Private	7	53

For the total industry, it is estimated that approximately 5 percent of the landfills utilized are owned by tanneries, 45 percent are publicly owned, and 50 percent are privately owned. As can be seen, tanneries tend to prefer off-site disposal if at all possible. However, some instances were noted in which off-site disposal facilities would not accept tannery waste. Reasons for refusal include the large volume of some tannery waste and the lack of facilities to handle tannery sludge which is often a liquid or slurry containing less than 10 percent solids. Thus, a tannery is then forced to operate its own disposal site. Public landfills are preferred by tanneries to those privately owned because of generally lower costs.

Waste Types. Most landfills accept all types of tannery waste, including wastewater treatment sludges. Potentially hazardous waste (including sludge) is usually mixed with municipal refuse, compacted, and covered. Landfill operators noted no particular difficulty in handling tannery waste when it was mixed in this manner. However, large quantities of only tannery waste, particularly blue trim and shavings, were sometimes difficult to spread and compact. Landfills accepting tannery sludge may either mix it with other refuse (tannery and municipal) or segregate it. At sites mixing the waste, operational difficulties have been encountered if the sludge is not sufficiently dewatered. Landfill equipment has become stuck in refuse/sludge landfills. However, if the ratio at which the sludge is mixed with other refuse in the landfill is appropriately controlled (as is the case for the certified hazardous waste disposal facility described later), operational difficulties are minimized. In one instance, sludge (not dewatered) was dumped in a separate area of a municipal landfill until it dried enough so that it could be mixed with refuse.

Adequacy. Tannery representatives and local and State government officials indicated that in their opinion sanitary landfilling is an appropriate method of disposal for most tannery waste. However, some felt that sanitary landfills were not appropriate for the disposal of wastewater treatment sludges. Due to the prevalence of and general satisfaction with sanitary landfilling and lacking regulations to the contrary, it is anticipated that virtually all waste, except wastewater treatment sludges, will be disposed of in landfills by 1983.

The potential for environmental damage as a result of sanitary landfilling of potentially hazardous waste depends upon the method of operation; the specific soil, geological and climatological characteristics of the site; and the composition and quantity of all of the solid waste disposed at the landfill, not just the fraction hauled from the tanneries. Although good engineering and site selection, in conjunction with careful attention to operating procedures, minimizes the potential for leachate generation, it does not eliminate the potential for surface or groundwater contamination as a result of leachate generation.[25] Data is unavailable to determine the extent to which environmental damage has resulted from landfilling of potentially hazardous tannery waste. However, experience with tannery waste and knowledge of landfill operation indicates that the potential for environmental damage exists.[26]

4.3.3 Certified Hazardous Waste Disposal Facilities.

In general, certified hazardous waste disposal facilities have been developed through modification of conventional sanitary landfills, or utilize trenches or pits. Additionally, these sites have forms of groundwater protection and operational procedures and safeguards required to properly handle chemical waste. Such operations "provide complete long-term protection for the quality of surface and subsurface waters from hazardous waste deposited therein, and against hazards to public health and the environment."[27] Direct contact between the waste and subsurface and surface water must be prevented, and leachate contained and treated. In addition, monitoring wells are often used for the sampling of groundwater in order to detect any leachate contamination as early as possible.

One of the privately owned certified hazardous waste disposal facilities that was visited received all potentially hazardous tannery waste, industrial and domestic sludges, and municipal refuse. Loads of sludge are spread between horizontal layers of municipal refuse at a mix rate not to exceed 50 liters of sludge per m^3 of dry material (in order to minimize leachate formation). The perimeter of the site is sealed with a compacted clay berm, and the 2.5 m deep lifts of solid waste are covered daily with clay, thus the operations are similar to a sanitary landfill. Leachate is collected and recirculated, and the gas generated is vented to the atmosphere. Since annual evaporation exceeds precipitation, leachate recirculation provides adequate groundwater protection. All haulers utilizing the site are required to have a permit for each source of waste, describing the composition and quantity of the waste. In addition, the site has monitoring wells which are sampled quarterly by the appropriate state and local agencies.

As discussed above in reference to landfills, the environmental adequacy of a landfill depends upon its design, location, operation, and the type and quantity of waste being accepted. Unlike a landfill, however, a certified hazardous waste disposal site, such as that described in the preceding paragraph, provides assurance of long-term protection of surface and subsurface waters and against public health and environmental hazards from the disposal of all types of potentially hazardous waste.

Based upon interviews at 41 tanneries and other research, it is estimated that 6 percent of the potentially hazardous waste generated by tanneries is disposed of in this manner. Most tanneries cited the limited availability of such sites and the normally higher disposal charges as the primary impediments to disposal of waste in certified hazardous waste disposal facilities--a situation which is not expected to change unless mandated by new regulations.

4.3.4 Disposal in Lagoons, Trenches, Pits, and Ponds. Lagoons, trenches, pits, and ponds are terms which are used somewhat interchangeably to refer to natural or manmade depressions which are used for the disposal of semi-solid waste. This type of disposal differs from landfilling in that the waste is covered only when the trench is filled.

This study identified nine sites of this type serving a total of 25 tanneries. Of the nine disposal sites, five were tannery owned, two were private, and two were municipal. Wastewater treatment sludges are the only potentially hazardous waste which is disposed in lagoons. It is estimated that 15 percent of tannery sludges which are disposed in lagoons or trenches go to on-site facilities, 40 to private sites, and 45 percent to municipal sites.

The environmental acceptability of lagoons for the disposal of semi-solid waste is dependent upon the methods and materials of construction, specific local hydrogeological conditions, and the types of waste which are handled. Unfortunately, the potential for significant contamination of subsurface waters from inadequately lined lagoons, both old and new, is appreciable due to improper location, construction, and/or design. Three of the nine lagoon sites identified were constructed with compacted clay liners. One of these had monitoring wells and another provided for treatment of the subsurface drainage from the lagoon. The other six sites were constructed of native earth materials.

The quantity of tannery sludge generated is estimated to increase 78 percent from 1974 to 1983. It is anticipated that lagoons will continue to be the primary method of disposal for tannery sludges if no regulations to the contrary are imposed.

4.3.5 Agricultural Spreading. With reference to potentially hazardous waste, agricultural spreading refers to the use of buffing dust and possibly other waste consisting of relatively small leather particles as a soil conditioner. One site was identified which received settled sludge from a buffing dust wet-scrubber collection device. The buffing dust sludge is dumped in piles on the edges of corn fields as it is generated. The farmer spreads the sludge whenever he has an opportunity, and the sludge is disced into the soil twice a year. Growth of the corn reportedly has improved since the addition of the sludge.

Analysis of emission spectroscopy of samples of corn collected from the area receiving buffing dust sludge and from an adjacent farm which does not receive any tannery waste, indicated that the concentrations of nickel, total chromium, lead, and iron were 10, 2, 10, and 5 times greater respectively, in the corn taken from the field receiving tannery waste. Since the significance of this observed metal concentration phenomenon is unclear, the environmental adequacy of this disposal practice is questionable.

In addition, buffing dust is considered to be a potentially hazardous waste since it contains high concentrations of lead, copper, and trivalent chromium. Information is not currently available to determine if land application of buffing dust will increase concentration levels beyond acceptable levels or if ground and surface water pollution will result. Consequently, this practice cannot be considered environmentally acceptable until further study is undertaken to determine the effects on crop composition, soil fertility, and adjacent groundwater and surface water quality.

4.4 Alternatives to Disposal

4.4.1 Municipal Sewage Treatment. Some tanneries are located in communities where most of the wastewater received at the municipal sewage treatment plant is discharged by tanneries. These situations are somewhat unique to the tannery industry and deserve mention.

The situation was particularly prevalent in New England (EPA Region I) where three tanneries were visited which provided 80 to 95 percent of the flow to municipal treatment facilities. In other New England and New York (EPA Region II) communities, up to 60 percent of the flow was contributed by tanneries. Thus, the municipalities were treating essentially tannery wastewater and generating and treating tannery sludge.

In the community in which the tannery contributed 95 percent of the flow, the primary treatment plant sludge was dewatered with horizontal, decanter-type centrifuges to 23 percent solids and disposed in trenches at the city's landfill. In the two other communities, the tanneries (a complete chrome tannery and a retan/finisher) contributed about 80 percent of the flow. Both of the treatment plants were constructed recently and neither was producing any secondary sludge. Primary sludge was being dewatered with decanter centrifuges with cakes about 25 to 28 percent solids. One operation was disposing of sludge in trenches. The other treatment plant was stockpiling the sludge near the plant until a disposal site was found.

Neither of the secondary treatment plants was experiencing major difficulties treating tannery wastewater. The plant serving the complete chrome tannery was specifically designed for tannery wastewater. It included a carbonation tank followed by a second primary clarifier for the precipitation of calcium carbonate (calcium from lime in beamhouse waste). Influent to this plant has a BOD of over 2,500 mg/l and effluent is approximately 100 mg/l BOD.

4.4.2 Source Reduction Through In-Plant Process Change.

Several tanneries have developed or are developing recovery and reuse programs designed to reduce chemical consumption and improve the quality of their wastewater. These programs include systems for recovery and reuse of hide soaking solutions, beamhouse sulfide liquors, and spent chrome tanning liquors. As reliable systems are developed, it is anticipated that the use of these recovery operations will gradually become more widespread. The effect of this will be a reduction in the quantity of wastewater treatment sludge generated at tanneries utilizing primary clarification and/or secondary wastewater treatment and which employ these recovery and reuse systems.[22]

It may be possible to accomplish potentially hazardous waste avoidance through the elimination of hazardous constituents (with the exception of chromium) from the chemicals used in the leather production process. Since laboratory analysis of samples of cattlehides, sheepskin, and pigskin before any tannery processing indicated that lead, zinc, and copper are present at only natural background levels, these metals appear in certain wastes as a result of the production process. Tannery experts indicate that these heavy metals are likely introduced in the retan, color, and finish operations in the form of dyes and/or pigments.[22,28] Contact with tanners and manufacturers of tannery chemicals indicate that substitute products have been developed which can be used in place of those containing lead, copper, and zinc. Such substitutions have already been adopted for chemicals containing mercury. However, the practice has not been extended to pigments containing other hazardous constituents because of the slightly different product obtained, the increased expense associated with the use of substitute organic dyes and pigments, and the general reluctance to change. With the advent of regulations governing the disposal of potentially hazardous waste, however, tanneries may find it cost-effective to utilize substitute organic dyes and pigments.

A few tanneries are looking to process and equipment changes that will improve overall tannery efficiency and coincidentally reduce waste quantities. "Splitting to weight," the extremely accurate splitting of tanned leather, is being employed by some tanneries to essentially eliminate the shaving of entire sides to obtain uniform thickness. Use of this technique reduces processing costs, increases the value of splits produced and reduces the volume of shavings requiring disposal.

The process, however, requires the use of sophisticated, expensive equipment and was only seen in a few tanneries visited during this project. It was the opinion of several tanners that the widespread use of splitting to weight will evolve slowly due to current investments in conventional splitting and shaving equipment, the high cost of the new machines, and reluctance on the part of some tanneries to change from traditional processes.

The segregation of wastewater streams within a tannery could reduce the quantity of potentially hazardous waste requiring land disposal. No hazardous constituents were found in beamhouse waste. Thus, if beamhouse wastewater (high in suspended solids) was segregated and separately clarified, the resultant sludge would not be a potentially hazardous waste, and in fact likely could be marketed as a soil conditioner due to its protein and lime content. One tannery is known to be using this approach. Wastestream segregation would require widely varying amounts of plant modification.

The process modifications described above are in various stages of development from experimental through pilot plant and full scale operation. However, none of the processes are in widespread use in any of the tannery categories, let alone the tanning industry as a whole. In addition, it is doubtful that many of the in-plant processes will come into widespread use by 1983.

The impression gathered from tannery officials during the course of this project was that tanning is considered an art. Each tanner feels that he knows the "tricks of the trade" as far as the production of his particular leather is concerned. Tanners strive to maintain a quality product of consistent color, texture, pattern, etc., in order to retain their established customers. Some tanners are not sure that they can reduce their chemical usage, use reformulated finishes, reuse chrome, etc., and still produce the same product, and thus are reluctant to make even minor changes in their processing.

Therefore, tanners will move slowly in altering their processing procedures. Since the in-plant process changes are not applicable to nor likely to be adopted by all tanneries in a particular category, no attempt has been made to suggest them to the entire industry. Consequently, in-plant process changes which impact on the quantity or nature of potentially hazardous waste have not been included as any level of treatment/disposal technology.

4.4.3 Sale as By-Products. Economic feasibility is currently the primary factor affecting by-product utilization of potentially hazardous waste. Following is a list of the types of potentially hazardous waste which are currently saleable:

Wastestream	By-product use
Blue trim and shavings	Fertilizer Hog feed supplement Glue
Solvent-based finish residues	Solvent recovery
Leather trimmings	Glue Crafts--small leather articles

With the exception of solvent recovery, by-product utilization of potentially hazardous waste is volatile and dependent upon location. Finished and unfinished leather trimmings are sometimes sold to foreign leather goods manufacturers in countries such as Korea, Japan, Hong Kong, and Taiwan, where, because of cheap labor, this material can be hand-sorted and manufactured into small leather products. However, this market depends on a variety of unstable variables, including freight rates, hide prices, labor cost and availability and market demand.

The major type of potentially hazardous waste sold is blue trim and shavings. These are, and have been, sold to producers of fertilizer, animal feed supplements, and glue. These markets are apparently declining as evidenced by the fact that within the last two decades the number of fertilizer producers utilizing leather waste has been reduced from 28 to 3. In addition, glue manufacturing from leather waste has essentially ceased. However, tanneries located in the Midwest are able to sell their blue trim and shavings to a producer of fertilizer used principally in citrus groves and to a lesser extent in other orchards. Similarly, some tanneries also sell blue trim and shavings for use a a hog feed supplement.

Sale of potentially hazardous waste for by-product uses is encouraged as an alternative to disposal if the ultimate use of the waste is environmentally sound. Blue trim and shavings are considered potentially hazardous due to their high trivalent chromium content. Information in the literature indicates that trivalent chromium is hazardous to aquatic organisms and to lower forms of terrestrial plant life, but not to mammals and higher plant forms. Consequently, the use of blue trim and shavings as a hog feed supplement is approved by USDA (chromium content not to exceed 275 ppm). Similarly, the use of this waste as an orchard fertilizer is encouraged as long as the application does not increase concentration levels beyond acceptable levels and ground and surface water pollution does not result from the practice. Use of the waste for other fertilizer applications, such as vegetable crops, must be studied further before the environmental adequacy of the practice is known.

4.5 Approach to the Selection of Treatment and Disposal Technologies

4.5.1 Technology Levels. For purposes of this report, three levels of technology for the treatment and disposal of potentially hazardous solid waste from leather tanning and finishing establishments were identified. These technology levels are characterized as follows[29]:

Level I --Technology currently employed by typical facilities, i.e., broad average present treatment and disposal practice.

Level II --Best technology currently employed. Identified technology at this level must represent the soundest process from an environmental and health standpoint currently in use in at least one location. Installations must be commercial scale; pilot and bench scale installations are not suitable.

Level III--Technology necessary to provide adequate health and environmental protection. Level III technology may be more or less sophisticated or may be identical with Level I or II technology. At this level, identified technology may include pilot or bench scale processes, providing the exact stage of development is identified.

The definition of Level III technology as defined in this report represents contract judgment, and not that of the EPA. This level of technology as defined for a particular potentially hazardous wastestream and/or process type is merely an attempt by the contractor to define an environmentally acceptable technology. Thus, the technology level defined should not be interpreted as a basis for future regulations. It is not based on cost-benefit, economic, or other analyses required to appropriately define Level III technology.[30]

4.5.2 Treatment. Treatment is applicable to only one wastestream from tanneries. Sludge from wastewater pretreatment or treatment facilities can be dewatered. Currently, tanneries in both the complete chrome and beamhouse/tanhouse categories dewater sludge. The removal of as much moisture as possible has lead to reduced on-site storage requirements, improved hauling, more acceptable disposal practices, and generally lower disposal cost. The previously described approaches of gravity and mechanical dewatering appear to be the only treatment methods applicable to wastewater treatment sludges. The single instance of gravity dewatering is being replaced by a filter press. Therefore, in those categories in which significant sludge is generated, mechanical dewatering is suggested for waste treatment.

4.5.3 Disposal. The potential hazard from tannery waste so designated comes from the possibility of heavy metals leaching from disposal sites and entering the surface or groundwater system. Thus, Level III technology will have to incorporate some safeguard to prevent leaching. On the other hand, no special handling methods or equipment are required at the disposal site for tannery waste. Level III technology for disposal of potentially hazardous waste is the use of landfills with a leachate collection system and an environmentally acceptable means of treatment and/or disposing of the leachate. This approach will prevent any heavy metals leached from the waste from entering the surface or groundwater system.

The other potential hazard associated with tannery waste is the flammability of some finish residues. These are disposed in relatively small quantities and on infrequent bases, e.g., 200 to 400 liters (50 to 100 gal) per week. Therefore, the normal, safe operation of a landfill with leachate collection should provide adequate protection from this potential hazard.

Tanneries generating potentially hazardous waste predominantly use off-site disposal. This is also true of the best current practices (Level II technology). Therefore, only off-site disposal is listed on the technology level tables in Sections 4.6 through 4.11. However, equivalent on-site disposal is also considered adequate.

4.5.4 Outline of Subsequent Sections. The six categories of tanneries generating potentially hazardous waste are discussed in turn in Section 4.6 through 4.11. The data presented in Section 3.0 for each category of tannery are summarized. Potentially hazardous wastestreams, their hazardous constituents, waste generation factors, and national totals for each waste type are shown.

The three treatment and disposal technology levels developed are presented for each category of tannery. In some instances, more than one alternative is listed for a single technology level. Each technology is evaluated using the following criteria:

- Current usage in the industry.
- Risk potential.
- Environmental adequacy (present and future).
- Monitoring techniques.
- Limitations.
- Impacts.
- Implementation time.

Treatment and disposal technologies pertinent to each category are discussed. The types and numbers of operations are listed. These tables provide the basis for the cost estimates presented in Section 5.0 for each level of technology for each category of tannery.

4.6 Treatment and Disposal: Complete Chrome Tanneries.

The potentially hazardous waste currently (1974) generated by complete chrome tanneries is summarized as follows:

Wastestream	Potentially hazardous constituents	Generation rate (wet/dry kg per 1000 eq. hides)	Nat't. total (wet/dry metric tons per year)
Trimmings and shavings	Cr	1,260/540	21,000/9,100
Unfinished leather trim	Cr, Pb, Cu	114/100	1,900/1,700
Buffing dust	Cr, Pb	27/25	460/420
Finished leather trim	Cr, Pb, Zn	220/200	3,700/3,400
Finishing residues	Cr, Pb, Zn	150/45	2,500/760
Wastewater screenings	Cr, Pb	390/90	6,600/1,500
Sewer sump sludge	Cr, Cu, Pb, Zn	2,700/300	37,000/4,100
Dewatered wastewater or treatment sludge	Cr, Cu, Pb, Zn	10,000/2,400	100,000/24,000

Treatment and disposal technology levels for complete chrome tanneries are presented in Table 44.

4.6.1 Treatment. The only type of potentially hazardous solid waste from a complete chrome tannery which is normally treated is the sludge from wastewater treatment or pretreatment facilities. The treatment utilized is mechanical dewatering (filter press, vacuum filter and centrifuge) which is discussed in Section 4.2 Individuals

TABLE 44

TREATMENT AND DISPOSAL TECHNOLOGY LEVELS FOR COMPLETE CHROME TANNERY

Amount of Waste: 104,000(wet)/28,000(dry) metric tons per year (1974)

Physical and Chemical Properties: Semi-solid and solid with toxic heavy metals (Pb,Zn,Cu,Cr), flammable solvents

	Level I	Level II	Level III	
			Alt. 1	Alt. 2
. Types of Wastes	All types	1) Trimmings and shavings 2) Other wastes	Same as Level II	1) Sludges 2) Trimmings and Shavings 3) Other wastes
. Technology	Off-site landfill	1) Sale as a by-product 2) Dewater sludges; all wastes to off-site certified hazardous waste disposal facility		1) Dewater and dispose in off-site lined trenches or landfill with leachate collection 2) Sale as a by-product 3) Off-site landfill with leachate collection
. Estimate of Current Usage				
- % of Complete Chrome Tanneries	50	1) 10 2) 4		1) 4 2) 10 3) 0
- # of complete Chrome Tanneries	52	1) 10 2) 4		1) 4 2) 10 3) 0
. Risk				
- Fire or Explosion	Slight	1) Nil 2) Slight		1&2) Nil 3) Slight
- Transportation	Slight	1) Nil 2) Slight		1&2) Nil 3) Slight
- Pollution	Moderate	1&2) Nil		1,2,&3) Nil
. Present Adequacy	Poor	1&2) Excellent		1,2,&3) Excellent
. Future Adequacy	Poor	1) Excellent 2) Good		1&3) Good 2) Excellent
. Monitoring Techniques	None	2) Groundwater wells		1&3) Groundwater wells
. Limitations and Problems	Fire hazard and worker safety and large quantities of wastes	1&2) Same as Level I 1) Volatile market		1&3) Soil conditions 2) Volatile market
. Non-Land Related Impacts	Surface and/or groundwater pollution potential	1&2) Nil		1,2,&3) Nil
. Implementation Time	Installed	1&2) Installed		1&3) 2 years 2) Not applicable

Source: SCS Engineers

experienced in tannery wastewater treatment prefer filter presses for dewatering tannery wastewater treatment sludges.[31] Although centrifuges, vacuum filters, and filter presses all seem to perform acceptably, the higher solids content of sludge dewatered with a filter press may favor its use in the future.

4.6.2 Disposal. All chrome tannery solid waste, with the exception of sewer sump or wastewater treatment sludges, is normally combined for disposal purposes. Nineteen disposal sites receiving complete chrome tannery waste other than sludges were visited:

- On-site dump--1.
- On-site landfill--1.
- Private landfill--8.
- Municipal dump--2.
- Municipal landfill--7.

Both tanneries which operate on-site disposal facilities also dispose of wastewater treatment sludges on-site. In both cases, the land and equipment were purchased primarily for sludge disposal.

Sixteen sites accepting sludge from complete chrome tanneries were visited:

- Private landfill--6.
- Municipal landfill--3.
- On-site (tannery) lagoons--4.
- Private (off-site) lagoons --2.
- Private certified hazardous waste disposal facilities--1.

Four tanneries operated on-site sludge disposal facilities because the local private or municipal disposal sites would not accept tannery sludge.

It is estimated that on a national basis 15 percent of the potentially hazardous waste generated by complete chrome tanneries currently (1974) is disposed of in on-site facilities. Fifteen percent is disposed in off-site lagoons or trenches; 16 percent is disposed in off-site dumps; 50 percent is diposed in off-site landfills; and 4 percent is disposed in certified hazardous waste disposal facilities.

4.7 Treatment and Disposal: Sheepskin Tanneries

The types and quantities of potentially hazardous solid waste generated by the sheepskin tanning industry are summarized below:

Wastestream	Potentially hazardous constituents	Generation rate (wet/dry kg per 1000 eq. hides)	Nat'l. total (wet/dry metric tons per year)
Chrome fleshings	Cr	1,200/300	3,000/750
Buffing dust	Cr, Pb, Cu, Zn	56/50	140/130
Leather trim	Cr, Pb, Cu	170/140	420/350
Wastewater screenings	Cr, Pb, Zn	230/50	570/120

Treatment and disposal technology levels for sheepskin tanneries are summarized in Table 45.

Sheepskin tanneries do not treat any of the potentially hazardous solid waste generated. All of the potentially hazardous waste listed above is normally combined in the plant and disposed together. Six disposal sites receiving potentially hazardous waste from sheepskin tanneries were visited. One was a municipal dump, two were municipal landfills, and three were private landfills. Since most of the sheepskin tanneries are located on the East and West Coasts in relatively urban areas, on-site waste disposal is not normally utilized.

On a national basis, it is estimated that 40 percent of potentially hazardous waste generated by sheepskin tanneries currently (1974) is disposed in municipal dumps, 30 percent in municipal landfills, and 30 percent in private landfills.

4.8 Treatment and Disposal: Split Tanneries

The four types of potentially hazardous waste which is generated by split tanneries is summarized below:

Wastestream	Potentially hazardous constituents	Generation rate (wet/dry kg per 1000 eq. hides)	Nat'l. total (wet/dry metric tons per year)
Trimmings, splits & shavings	Cr	8,200/3,700	28,000/13,000
Buffing dust	Cr, Pb	200/180	690/620
Unfinished leather trim	Cr, Pb	230/200	790/690
Wastewater screenings	Cr, Pb	22/5	75/17

TABLE 45

TREATMENT AND DISPOSAL TECHNOLOGY LEVELS FOR SHEEPSKIN TANNERY

Amount of Waste: 4,100(wet)/1,300(dry) metric tons per year

Physical and Chemical Properties: Solid, containing toxic heavy metals (Pb,Zn,Cu)

	Level I	Level II	Level III
. Types of Wastes	All types	Same as Level I	All types
. Technology	Off-site landfill		Off-site landfill with leachate collection
. Estimate of Current Usage			
- # of Sheepskin Tanneries	60		0
- # of Sheepskin Tanneries	26		0
. Risk			
- Fire or Explosion	Slight		Slight
- Transportation	Slight		Slight
- Pollution	Moderate		Nil
. Present Adequacy	Fair		Excellent
. Future Adequacy	Fair		Good
. Monitoring Techniques	--		Groundwater wells
. Limitations and Problems			Soil conditions
. Non-Land Related Impacts	Surface and/or groundwater pollution potential		--
. Implementation Time	Installed		2 years

Source: SCS Engineers

Treatment and disposal technology levels for split tanneries are summarized in Table 46 .

None of the potentially hazardous waste from a split tannery receives treatment of any kind prior to disposal. All split tannery waste is normally combined in the plant and disposed together. Three disposal sites receiving potentially hazardous waste were visited; one was a municipal landfill, and two were private landfills. Since split tanneries are normally located in urban areas, virtually all split tannery solid waste is disposed off-site.

Available information indicates that 70 percent of the potentially hazardous waste generated by split tanneries is currently (1974) being disposed in municipal dumps and that 30 percent is being disposed in landfills. The high percentage using dumps is due to the location of these operations--New England (EPA Region I) where dumps are common. In addition, the split tanneries in the Midwest (EPA Regions V and VII) are able to sell their trimmings and shavings and thus they are not waste.

4.9 Treatment and Disposal: Leather Finishers

The potentially hazardous waste which is generated by leather finishers is listed below:

Wastestream	Potentially hazardous constituents	Generation rate (wet/dry kg per 1000 eq. hides)	Nat'l. total (wet/dry metric tons per year)
Buffing dust	Cr, Pb	11/10	61/56
Finishing residue	Cr, Pb, Zn & solvents	150/45	830/250

Treatment and disposal technology levels for leather finishers are summarized in Table 47.

Neither of this potentially hazardous waste is treated prior to disposal. Instead, this and other waste (non-process waste from offices, etc.) is normally combined either during collection or hauling to the disposal site.

Since essentially all leather finishers are located in urban areas and because finishers do not generate large quantities of waste, off-site facilities are used for all waste disposal.

Three disposal sites receiving potentially hazardous waste from finishers were visited, of which two were municipal dumps, and one was a private landfill. Although use of municipal dumps is typical for their location, disposal in dumps is not typical for leather finishers. Therefore, estimates of the type of solid waste disposal

TABLE 46

TREATMENT AND DISPOSAL TECHNOLOGY LEVELS
FOR SPLIT TANNERY

Amount of Waste: 16,000(wet)/7,900(dry) metric tons per year

Physical and Chemical Properties: Solid, Containing Toxic Heavy Metals (Pb and Cr)

	Level I	Level II	Level III	
			Alt. 1	Alt. 2
. Types of Wastes	All types	1) Trimmings and Shavings 2) Other wastes	All types	1) Trimmings and Shavings 2) Other wastes
. Technology	Off-site dumping	1) Sale as a by-product 2) Off-site landfill	Off-site landfill with leachate collection	1) Sale as a by-product 2) Off-site landfill with leachate collection
. Estimate of Current Usage				
- % of [illegible]	70	1&2) 10	0	1) 6 2) 0
- # of Tanneries	17	1&2) 7	0	1) 1 2) 0
. Risk				
- Fire or Explosion	Nil	1) Nil 2) Nil	Nil	1&2) Nil
- Transportation	Slight	1) Nil 2) Slight	Slight	1) Nil 2) Slight
- Pollution	Moderate	1) Nil 2) Moderate	Nil	1&2) Nil
. Present Adequacy	Poor	1) Excellent 2) Fair	Good	1&2) Excellent
. Future Adequacy	Poor	1) Excellent 2) Fair	Good	1&2) Excellent
. Monitoring Techniques	--	--	Groundwater wells	2) Groundwater wells
. Limitations and Problems	--	1) Volatile and Geographically concentrated market	Soil conditions	1) Volatile and geographically concentrated market 2) Soil conditions
. Non-Land Related Impacts	Surface and/or groundwater pollution potential	2) Surface and/or groundwater pollution potential	---	---
. Implementation Time	Installed	1&2) Installed	2 years	2 years

Source: SCS Engineers

TABLE 47

TREATMENT AND DISPOSAL TECHNOLOGY LEVELS FOR LEATHER FINISHERS

Amount of Waste: 900(wet)/300(dry) metric tons per year (1974)

Physical and Chemical Properties Buffing dust contains heavy metals (Cr,Pb): *finishing residues contain heavy metals (Cr,Pb,Zn); and some are flammable

	Level I	Level II	Level III
. Types of Wastes	1) Buffing dust 2) Finishing residues	Same as Level I	1) Buffing dust 2) Finishing residues
. Technology	1&2) Off-site landfill		1) Off-site landfill with leachate collection 2) Off-site
. Estimate of Current Usage			
- % of Finishers	1&2) 60		0
- # of Finishers	1&2) 41		0
. Risk			
- Fire or Explosion	1) Slight 2) Substantial		1) Nil 2) Slight
- Transportation	1) Nil 2) Slight		1) Nil 2) Slight
- Pollution	1) Moderate 2) Substantial		1&2) Nil
. Present Adequacy	1) Fair 2) Poor		1) Excellent 2) Good
. Future Adequacy	1) Fair 2) Poor		1) Excellent 2) Good
. Monitoring Techniques	None		1&2) Groundwater wells
. Limitations and Problems	1) Soil conditions 2) Fire hazard, soil conditions and worker safety		1&2) Soil conditions
. Pollution Related Impacts	1&2) Surface and/or groundwater pollution potential		
. Implementation Time	Installed		1&2) 2 years

Source: SCS Engineers

* Buffing dust contains heavy metals; finishing residues contain heavy metals, and some are flammable.

facilities utilized nationwide are based upon information obtained for solid waste from complete chrome tanneries (excluding wastewater sludges). Thus, on a national basis, 35 percent of the potentially hazardous waste generated by finishers is currently (1974) disposed in municipal landfills, 40 percent in municipal dumps and 25 percent in private landfills.

Level III technology calls for finishing residues to be disposed in certified hazardous waste disposal facilities. This is because these sites are more likely able to handle the potential fire hazard from the residues which make up a larger proportion of a leather finisher's waste than that of any other tannery category. However, if there are no certified hazardous waste disposal facilities in the area, landfills with leachate collection could be used for disposal as long as the finishing residues are mixed in with other waste so as to prevent flammability hazards.

4.10 Treatment and Disposal: Beamhouse/Tanhouse Facility

The potentially hazardous waste which is generated by the beamhouse/tanhouse facility is:

Wastestream	Potentially hazardous constituents	Generation rate (wet/dry kg per 1000 eq. hides)	Nat'l. total (wet/dry metric tons per year)
Wastewater sludge	Cr, Cu, Pb, Zn	8,500/2,500	18,000/5,300

Treatment and disposal technology levels for beamhouse/tanhouse facilities are summarized in Table 48.

4.10.1 Treatment. Wastewater treatment sludges are normally treated prior to disposal. The only type of treatment utilized is dewatering, and this is accomplished on-site by non-mechanical (sequential settling) or mechanical (filter press, vacuum filter or centrifuge) means. Two beamhouse/tanhouse facilities which treat their wastewater pretreatment sludge were visited. One used the sequential settling and one used a filter press. In order to reduce hauling and disposal charges by further reducing the moisture content of the sludge, the plant currently employing the sequential settling method of sludge dewatering is in the process of installing a filter press. Both plants indicated their preference for the use of filter presses for sludge dewatering because they are reliable and effective (yielding a 40 percent solids filter cake).

TABLE 48

TREATMENT AND DISPOSAL TECHNOLOGY LEVELS FOR BEAMHOUSE/TANHOUSE FACILITY

Amount of Waste: 21,000(wet)/5,000(dry) metric tons per year (1974)

Physical and Chemical Properties: Sludges with 20 to 40 percent solids containing toxic heavy metals (Pb,Cr)

	Level I	Level II	Level III	
			Alt. 1	Alt. 2
. Types of Wastes	Sludge	Sludge	as Level II	Sludge
. Technology	Dewater and dispose in off-site landfill	Dewater and dispose in off-site lined trenches		Dewater and dispose in off-site landfill with leachate collection
. Estimate of Current Usage				
- % of Beamhouse/ Tanhouse	60	20		0
- # of Beamhouse/ Tanhouse	6	2		0
. Risk				
- Fire or Explosion	Nil	Nil		Nil
- Transportation	Nil	Nil		Nil
- Pollution	Substantial	Slight		Nil
. Present Adequacy	Fair	Good		Excellent
. Future Adequacy	Poor	Fair		Good
. Monitoring Techniques	--	Groundwater wells		Groundwater wells
. Limitations and Problems	Ground and surface water pollution	Soil conditions		Soil conditions
. Non-land Related Impacts	Ground and surface water pollution	--		--
. Implementation Time	Installed	Installed		2 years

Source: SCS Engineers

4.10.2 Disposal. One private disposal site which accepts wastewater pretreatment sludge from a beamhouse/tanhouse facility was visited. The site is state certified to accept tannery waste. At this disposal site, the sludge is placed in clay-lined trenches (Level II technology). The bottom of the trenches are sloped to allow excess water from the deposited sludge to drain to the low end. As this liquid accumulates, it is pumped out of the trench into an adjacent evaporative lagoon. When the trenches become approximately one-half filled with sludge, they are completely covered and sealed with the clay soil which was originally excavated. The site has only recently been put into operation and the first sludge trenches constructed are still being filled. The site operators indicated that they have not encountered any particular problems with operation of the site.

On a national basis, it is estimated that 40 percent of the potentially hazardous waste generated by beamhouse/tanhouse facilities is disposed in facilities utilizing trenches or lagoons and that 60 percent is disposed in off-site landfills. It is known that by 1983 at least one new beamhouse/tanhouse facility probably will be operating with on-site evaporative lagoons.

4.11 Treatment and Disposal: Retan/Finishers

The six types of potentially hazardous waste generated by retan/finishers is summarized below:

Wastestream	Potentially hazardous constituents	Generation rates (wet/dry kg per 1000 eq. hides)	Nat'l. total (wet/dry metric tons per year)
Trimmings & shavings	Cr	1,300/540	2,600/1,100
Unfinished leather trim	Cr, Cu, Pb	110/100	240/210
Buffing dust	Cr, Pb	27/25	60/50
Finished leather trim	Cr, Pb, Zn	220/200	460/420
Finishing residues	Cr, Pb, Zn & organic solvents	150/45	310/90
Screenings	Cr, Pb	40/10	80/20

Treatment and disposal technology levels for retan/finishers are summarized in Table 49 .

TABLE 49

TREATMENT AND DISPOSAL TECHNOLOGY LEVELS FOR RETAN/FINISHERS

Reproduced from best available copy.

Amount of Waste: 4,500(wet)/2,300(dry) metric tons per year

Physical and Chemical Properties: Flammable, semi-solid and solid with toxic heavy metals (Pb,Zn,Cu,Cr)

	Level I	Level II	Level III	
			Alt. 1	Alt. 2
. Types of Wastes	All types	1) Trimmings and shavings 2) Other wastes	All types	1) Trimmings and shavings 2) Other wastes
. Technology	Off-site landfill	1) Sale as a by-product 2) Off-site landfill	Off-site landfill with leachate collection	1) Sale as a by-product 2) Off-site landfill with leachate collection
. Estimate of Current Usage				
- % of Retan/Finish Plants	55	1) 4 2) 55	0	0
- # of Retan/Finish Plants	12	1) 1 2) 12	0	0
. Risk				
- Fire or Explosion	Slight	1) Nil 2) Slight	Slight	1) Nil 2) Slight
- Transportation	Slight	1) Nil 2) Slight	Slight	1) Nil 2) Slight
- Pollution	Moderate	1) Nil 2) Moderate	Nil	1&2) Nil
. Present Adequacy	Fair	1) Excellent 2) Fair	Excellent	1&2) Excellent
. Future Adequacy	Poor	1) Excellent 2) Poor	Good	1&2) Excellent
. Monitoring Techniques	None	1&2) None	Groundwater wells	2) Groundwater wells
. Limitations and Problems	Fire hazard and worker safety	2) Fire hazard and worker safety	Soil conditions	1) Volatile market 2) Soil conditions
. Non-Land Related Impacts	Surface and/or groundwater pollution potential	2) Surface and/or groundwater pollution potential	---	---
. Implementation Time	Installed	1-2 years	2 years	2 years

Source: SCS Engineers

None of the above waste types are treated prior to disposal. All of the waste is normally combined for disposal purposes either during collection, hauling to the disposal site, or in the disposal operation. Four disposal sites receiving potentially hazardous waste generated by retan/finishers were visited, of which two were municipal dumps and two were municipal landfills.

Operations at one municipal dump have been altered because of the acceptance of tannery waste. Until recently, the tannery waste was mixed with municipal refuse. When this mixture burned, (reportedly a frequent occurrence) citizens complained about the obnoxious odor. To alleviate this problem, the tannery now disposes its waste (primarily blue trimmings and shavings) in a separate area of the dump. Weekly, a crawler dozer spreads the waste and covers it with imported cover material. This procedure prevents the trimmings and shavings from burning.

It is estimated that on a national basis 35 percent of the potentially hazardous waste generated by retan/finishers is disposed at municipal landfills; 20 percent is disposed at private landfills; 15 percent is disposed at on-site facilities; and 30 percent is disposed at municipal dumps.

4.12 Treatment and Disposal Technologies and Waste Quantity Summary

The treatment and disposal technologies and the current (1974) distribution of waste between the three levels of technology are summarized in Table 50 . As shown, landfilling is the most common Level I and Level II disposal technology. For all categories of tanneries, a landfill with leachate collection provides adequate environmental protection (Level III). Other acceptable Level III disposal technologies include landfills and lined trenches certified for hazardous waste disposal.

Wastewater pretreatment/treatment sludge is the only type of potentially hazardous waste which requires treatment prior to disposal. Dewatering of the sludge prior to disposal is the only type of treatment required. Sludge dewatering is common at large tanneries which treat their wastewater, and is included in all levels of technology for complete chrome tanneries and beamhouse/tanhouse facilities which generate sludge.

Comparison of the quantity of waste going to Level III with the total quantity of potentially hazardous waste generated reveals that only 6 percent is going to Level III. Similarly, 12 percent is going to Level II and 87 percent is going to Level I. Note that the sum of Level I, II, and III percentages is greater than 100 due to overlaps between the various levels, as shown in Table 50 .

TABLE 50

TREATMENT AND DISPOSAL TECHNOLOGY LEVELS AND ASSOCIATED POTENTIALLY HAZARDOUS WASTE QUANTITIES

Category	Treatment/Disposal Technology			Current (1974) Distribution of Waste Between Treatment/Disposal Technologies					
	Level I	Level II	Level III	Level I		Level II		Level III	
				metric tons/yr (wet/dry)	%	metric tons/yr (wet/dry)	%	metric tons/yr (wet/dry)	%
Complete chrome tannery	Landfill	Dewater sludge, all waste disposed in certified hazardous waste disposal facility	Same as Level II, landfill with leachate collection	52,000/14,000	50	4,200/1,200	4	4,200/1,200	4
Sheepskin tannery	Landfill	Landfill	Landfill with leachate collection	2,500/800	60	2,500/800	60	0	0
Split tannery	Dump	Landfill	Landfill with leachate collection	11,200/5,500	70	4,800/2,400	30	0	0
Leather finisher	Landfill	Landfill	Landfill with leachate collection	540/180	60	540/180	60	0	0
Beamhouse/ tanhouse facility	Dewatered sludge, disposed in landfill	Dewatered sludge disposed in lined trenches	Same as Level II, or landfill with leachate collection	12,600/3,000	60	4,200/1,000	20	4,200/1,000	20
Retan/finsher	Landfill	Landfill	Landfill with leachate collection	2,500/1,300	55	2,500/1,300	55	0	0

Source: SCS Engineers

As shown approximately 34 percent of the total quantity of potentially hazardous waste generated by the tanning industry comes from complete chrome tanneries and goes to Level I (landfills). Similarly, 7 percent of the waste comes from split tanneries and goes to Level I (dumps) and 8 percent comes from beamhouse/tanhouse facilities and goes to Level I (landfills).

Since about 34,000 metric tons (wet weight) of sludge from complete chrome tanneries and 12,600 metric tons (wet weight) of sludge from beamhouse/tanhouse facilities goes to Level I disposal (landfills), 57 percent of the waste going to Level I treatment and disposal technology is wastewater treatment sludge. Similarly, 44 percent of the waste (wet weight basis) going to Level II and 95 percent of the waste going to Level III is wastewater treatment sludge.

SECTION 5.0

COST ANALYSIS

In this section, the costs associated with the three levels of potentially hazardous waste treatment and disposal technology in the leather tanning industry are developed. The cost information in this section is primarily based on data collected during interviews with tannery representatives. As necessary, additional information is included from equipment suppliers, published literature, and government sources. Wherever possible, the cost data presented is from actual installations, and from prices quoted by tannery solid waste disposal contractors.

The general assumptions and bases for the cost analyses are presented in Section 5.1. The costs associated with on-site treatment of potentially hazardous waste are presented in Section 5.2, and the costs associated with contractor hauling and disposal are presented in Section 5.3. The costs of the various levels of treatment and disposal technology for typical plants from each of the six categories of tanneries generating potentially hazardous waste and for the industry as a whole are presented in Section 5.4, and the variables which effect these costs are discussed in Section 5.5. An example of the cost calculation methodology utilized to develop the treatment and disposal costs for the typical plants is presented in Section 5.6.

5.1 Bases and Criteria for Cost Estimation

The basic information utilized to develop the cost estimates presented in Section 5.4 is shown in Table 51 and discussed in the following paragraphs.

5.1.1 Capital Costs. As used in this analysis, capital costs include all expenditures associated with the development and installation of treatment and disposal facilities. These costs include engineering consulting services, equipment purchase and installation, electrical and plumbing connections, buildings, start-up costs, and land costs where applicable. Capital costs known for specific plants were factored to account for capacity differences and averaged to develop the costs for the typical plants.

5.1.2 Interest Costs. It has been assumed that private debt financing is used for treatment and disposal facility investment. In addition, the cost of capital has been assumed to be equal to 10 percent annual rate of interest on investment.

Preceding page blank

TABLE 51

BASES AND CRITERIA FOR COST ESTIMATION

Cost of Capital = 10 percent annual interest

Time Index = December 1973 dollars

Depreciation = Straight line over useful service life of equipment

Estimated Equipment Life:

- mobile -- 5 years
- stationary--10 years

Land Value = $50,000/ha ($20,000/ac)

Operating Costs:

Labor (including 33% fringe benefits) = $4.80 per hour
Supervision (assumed) = 10 percent of labor
Maintenance = average of costs reported by applicable tanneries visited
Materials = average of costs
Insurance and Taxes = 2 percent of capital
Electrical Power = $0.02 per
Contract Services = average of costs reported by applicable tanneries visited

Source: **SCS Engineers**

5.1.3 Time Index for Costs. All cost estimates have been adjusted to December 1973 dollars, using the Chemical Engineering (CE) Plant Cost Index.

5.1.4 Useful Service Life. The useful service life of treatment and disposal equipment varies depending upon factors such as usage pattern and maintenance schedule. Based upon information obtained from private industry sources, the following generalizations have been made with regard to the service life of treatment and disposal equipment used in the leather tanning industry:

- Lagoons--20 years.
- Mobile equipment--5 years.
- Stationary equipment--10 years.

5.1.5 Depreciation. For the purposes of this cost analysis, it has been assumed that the salvage or recovery value of treatment and disposal equipment is zero at the end of its useful service life. In order to annualize the capital costs incurred by tanneries as a result of treatment and disposal equipment, straight line depreciation has been utilized over the useful life of the service equipment.

5.1.6 Operating Expenses. The annual costs associated with operating the treatment and disposal facilities include labor, supervision, maintenance, taxes, insurance, materials, and energy. For purposes of clarity, costs associated with energy consumption are itemized separately from other operating expenses, as are maintenance costs. No interest costs for operating capital are included in the operating expenses.

5.2 On-Site Waste Treatment

Sludges resulting from primary and/or secondary treatment of wastewater at beamhouse/tanhouse facilities and some complete chrome tanneries are the only type of potentially hazardous waste which receive treatment prior to disposal. All sludge treatment is performed on-site, except for tanneries discharging to municipal wastewater treatment facilities, and consists of non-mechanical (sequential settling) or mechanical dewatering systems. Since only one tannery was identified which utilizes a non-mechanical sludge dewatering system and this tannery is currently in the process of replacing it with a filter press, only mechanical systems are considered in these cost estimates.

Filter presses, centrifuges, and vacuum filters are all used in a variety of situations for dewatering tannery wastewater treatment sludges. As a result, the cost information presented in Tables 54 and 58 for the typical complete chrome tannery (with wastewater pretreatment) and the beamhouse/tanhouse facility, respectively, is the average of the costs associated with two filter press, one centrifuge, and one vacuum filter systems. This cost information was collected during visits to four tanneries utilizing these systems.

5.3 Off-Site Disposal

The typical plants from all six categories of tanneries which generate potentially hazardous waste hire contractors to haul and dispose their waste off-site. Although a few tanneries with wastewater treatment systems dispose potentially hazardous waste on-site and other tanneries haul their own waste, these practices are atypical for all categories in the tanning industry.

The costs of contractor hauling and disposal of the potentially hazardous waste are based on information obtained from tanneries. Tannery quoted unit costs, which are presented in Table 52 , range from $2 per metric ton for disposal in an open dump to $10 per metric ton for disposal (from a large complete chrome tannery) in a state certified hazardous waste disposal site to $31 per metric ton for disposal (from a small finisher) in a landfill. The range in disposal costs are due to a variety of factors, including, distance from the disposal site, regional location, and the volume of waste generated by a particular tannery. Adjusted costs are indicated in Table 52 to:

- Provide data where no tannery quoted costs were available.
- Take into account diseconomies due to small volumes .
- Account for unusual quoted unit costs.
- Account for leachate collection at landfills.

Total costs are the overall hauling and disposal costs for each type of waste and are the figures used in subsequent cost estimates. Both tannery-quoted and adjusted costs for dewatered sludge are shown and the total cost is the same as the adjusted cost. This is due to abnormally low tannery-quoted costs.

5.4 Treatment and Disposal Costs

A summary of the cost estimates for three levels of treatment and disposal technology for a typical plant in the six categories of tanneries which generate potentially

TABLE 52

CONTRACTOR HAULING AND DISPOSAL COSTS

		Dec. 1978 dollars per metric ton (wet weight basis)		
Typical tannery	Disposal method	Tannery quoted costs	Adjusted costs	Total costs
Solids				
Complete chrome tannery w/o sludge	Landfill	10[(a)]		10
	Landfill with leachate collection		14	14
Sheepskin tannery	Landfill		20	20
	Landfill with leachate collection		24	24
Split tannery	Dump (including trimmings and shavings)	2[(b)]		2
	Landfill with leachate collection			
	- including trimmings and shavings		14	14
	- without trimmings and shavings		24	24
Leather finisher	Landfill	31[(c)]		
	Landfill with leachate collection		35	35
	Certified hazardous waste disposal facility		46	46
Retan/finisher	Landfill (including trimmings and shavings)		10	10
	Landfill (without trimmings and shavings)		20	20
	Landfill with leachate collection			
	- including trimmings and shavings		14	14
	- without trimmings and shavings		24	24
Dewatered Sludge				
Complete chrome tannery with sludge	Landfill	4[(d)]	10	10
	Landfill with leachate collection		14	14
	Certified hazardous waste disposal facility	10[(e)]	16	16
Beamhouse/tanhouse facility	Lined trenches	7[(f)]	12	12

Source: SCS Engineers

(a) Average of 12 tanneries.
(b) Average of two split tanneries and one complete chrome tannery.
(c) Average of two finishers.
(d) Average of three complete chrome tanneries.
(e) From one complete chrome tannery.
(f) From one beamhouse/tanhouse facility.

hazardous waste is presented in Tables 53 through 59 . The cost items shown in these tables include land, total capital investment, annual capital cost, operation, maintenance, energy and power, contract services, total annual cost, and total treatment and disposal cost per unit of product and of potentially hazardous waste.

At the recommendation of the Tanners' Council of America, the median tannery (with respect to production) was chosen as the typical plant for each category. Since the production of the largest plant in a category is over 100 times that of a small plant, the median is chosen as the best estimate of a typical operation.

All typical plants are located in urban areas, predominantly in the East or Midwest (EPA Regions I, II, III, IV) and utilize contract services for solid waste hauling and disposal. All of the typical plants are 50 years old with the exception of the beamhouse/tanhouse facility which is 15 years old.

As shown, the total annual cost for Level I and Level III is the same for a typical complete chrome tannery without primary and/or secondary wastewater treatment. Although the cost per metric ton of waste is higher for Level III, due to higher costs for disposal in a landfill with leachate collection, the total cost is the same since Level III assumes that trimmings and shavings are sold as a by-product, whereas Level I calls for landfilling of this waste.

For a complete chrome tannery with primary and/or secondary wastewater treatment, the total fixed cost is due entirely to sludge dewatering. Sludge dewatering accounts for approximately 90 percent of the increase in the total annual cost for complete chrome tanneries with primary and/or secondary wastewater treatment relative to complete chrome tanneries without wastewater treatment facilities. The other 10 percent of the increase in costs is the result of sludge disposal charges.

In the sheepskin tannery category, the cost of Level III technology is slightly higher than Levels I and II due to the requirement that leachate collection be provided in Level III disposal technology. The cost per ton of waste disposed for all three levels is approximately twice that for complete chrome tannery without primary and/or secondary wastewater treatment. This variation in cost per ton arises because substantially different quantities of waste are generated by these two types of tanneries.

Two different Level III treatment and disposal technologies are shown for split tanneries, one of which is substantially more expensive than Level I and one which is slightly less expensive. The cost shown for Level I is based on open dumping of all the potentially hazardous waste generated. The more expensive Level III technology (Alternative 1) is based on disposal of the same quantity

TABLE 53

TREATMENT AND DISPOSAL COSTS
TYPICAL COMPLETE CHROME TANNERY
(without primary and/or secondary wastewater treatment)

	Annual Production (1974)	Location	Manufacturing Process
Typical Plant Characteristics	260,000 equivalent hides/year	Urban, Region I or V	Chrome tanning & leather finishing

Identification of Wastestream(s)	Potentially Hazardous Constituents	Physical Form	Amount for Treatment/Disposal (wet/dry kg per 1000 hides)
Trimmings & shavings	Cr	Solid	1,260/540
Unfinished leather trimmings	Cr,Pb	Solid	114/100
Buffing dust	Cr,Pb	Solid	27/25
Finished leather trim	Cr,Pb	Solid	220/200
Finishing residues	Cr,Pb,Zn	Liquid	150/45
Wastewater screenings	Cr,Pb	Solid	390/90
Sewer sump sludge	Cr,Pb,Cu	Liquid	2,700/300

Treatment/Disposal Costs/Levels	Dollars (Dec. 1973)		
	Level I	Level II	Level III
Annual contract hauling & disposal charges	13,000	10,000	13,000
Average treatment & disposal cost			
- per unit of production ($/1000 hides)	46	38	46
- per metric ton of waste*	10	10	14

Description of Treatment/Disposal Technology:

Level I	Off-site landfill
Level II	Trimmings and shavings sold; other waste to off-site landfill
Level III	Trimmings and shavings sold; other waste to off-site landfill with leachate collection

Source: SCS Engineers

* On a wet weight basis.

TABLE 54

TREATMENT AND DISPOSAL COSTS
TYPICAL COMPLETE CHROME TANNERY
(with primary and/or secondary wastewater treatment)

	Annual Production (1974)	Location	Manufacturing Process
Typical Plant Characteristics	260,000 equivalent hides/year	Urban, Region I or V	Chrome tanning & leather finishing

Identification of Wastestream(s)	Potentially Hazardous Constituents	Physical Form	Amount for Treatment/Disposal (wet/dry kg per 1000 hides)
Trimmings & shavings	Cr	Solid	1,260/540
Unfinished leather trimmings	Cr,Pb	Solid	114/100
Buffing dust	Cr,Pb	Solid	27/25
Finished leather trim	Cr,Pb	Solid	220/200
Finishing residues	Cr,Pb,Zn	Liquid	150/45
Wastewater screenings	Cr,Pb	Solid	390/90
Wastewater sludge (dewatered)	Cr,Pb,Cu	Sludge cake	10,000/2,400

Treatment/Disposal Costs/Levels	Dollars (Dec. 1973)			
	Level I	Level II	Level III	
			Alt. 1	Alt. 2
Investment Costs				
Land	4,000	4,000	4,000	4,000
Other	300,000	300,000	300,000	300,000
Total Fixed	304,000	304,000	304,000	304,000
Annual Costs				
Capital Costs	60,400	60,400	60,400	60,400
Operating	18,000	18,000	18,000	18,000
Maintenance	5,000	5,000	5,000	5,000
Energy	2,400	2,400	2,400	2,400
Contract Services	31,600	45,300	45,300	39,700
Total Annualized	117,400	131,100	131,100	125,500
Average treatment & disposal cost				
- per unit of production ($/1000 hides)	451	504	504	482
- per metric ton of waste*	37	46	46	44

Description of Treatment/Disposal Technology:

Level I	Off-site landfill
Level II	Trimmings and shavings sold; other wastes (including dewatered sludge) to off-site certified hazardous waste disposal facility
Level III	Alt. 1: Same as Level II Alt. 2: Trimmings and shavings sold as a by-product; other wastes to off-site landfill with leachate collection

Source: SCS Engineers

* On a wet weight basis.

TABLE 55

TREATMENT AND DISPOSAL COSTS TYPICAL SHEEPSKIN TANNERY

	Annual Production (1974)	Location	Manufacturing Process
Typical Plant Characteristics	200,000 equivalent hides/year	Urban, Region I or II	Sheepskin tanning

Identification of Wastestreams(s)	Potentially Hazardous Constituents	Physical Form	Amount for Treatment/Disposal (wet/dry kg per 1000 hides)
Chrome fleshings	Cr	Slurry	1,200/300
Unfinished leather trimmings	Cr,Cu.Pb	Solid	170/140
Buffing dust	Cr,Pb,Cu,Zn	Solid	56/50
Wastewater screenings	Cr,Cu	Solid	230/50

Treatment/Disposal Costs/Levels	Dollars (Dec. 1973)		
	Level I	Level II	Level III
Annual contract hauling & disposal charges	6,700	6,700	8,100
Average treatment & disposal cost			
- per unit of production ($/1000 hides)	34	34	40
- per metric ton of waste*	20	20	24

Description of Treatment/Disposal Technology:

Level I	Off-site landfill
Level II	Off-site landfill
Level III	Off-site landfill with leachate collection

Source: SCS Engineers

* On a wet weight basis.

TABLE 56

TREATMENT AND DISPOSAL COSTS
TYPICAL SPLIT TANNERY

	Annual Production (1974)	Location	Manufacturing Process
Typical Plant Characteristics	400,000 equivalent hides/year	Urban, Region I	Retanning cattle hide splits

Identification of Wastestream(s)	Potentially Hazardous Constituents	Physical Form	Amount for Treatment/Disposal (wet/dry kg per 1000 hides)
Trimmings, splits & shavings	Cr	Solid	8,200/3,700
Unfinished leather trimmings	Cr,Pb	Solid	230/200
Buffing dust	Cr,Pb	Solid	200/180
Wastewater screenings	Cr,Pb	Solid	22/5

Treatment/Disposal Costs/Levels	Dollars (Dec. 1973)			
	Level I	Level II	Level III	
			Alt. 1	Alt. 2
Annual contract hauling & disposal charges	7,000	3,600	48,000	4,300
Average treatment & disposal cost				
- per unit of production ($/1000 hides)	17	9	121	11
- per metric ton of waste*	2	20	14	24

Description of Treatment/Disposal Technology:

Level I	Off-site dumping
Level II	Trimmings and shavings sold as a by-product; other wastes off-site landfill
Level III	Alt. 1: Off-site landfill with leachate collection Alt. 2: Trimmings and shavings sold as a by-product; other wastes to off-site landfill with leachate collection

Source: SCS Engineers

* On a wet weight basis.

TABLE 57

TREATMENT AND DISPOSAL COSTS TYPICAL LEATHER FINISHER

	Annual Production (1974)	Location	Manufacturing Process
Typical Plant Characteristics	225,000 equivalent hides/year	Urban, Region I or II	Leather finishing

Identification of Wastestream(s)	Potentially Hazardous Constituents	Physical Form	Amount for Treatment/Disposal (wet/dry kg per 1000 hides)
Buffing dust	Cr,Pb	Solid	11/10
Finishing residues	Cr,Zn,Pb	Liquid	150/55

Treatment/Disposal Costs/Levels	Dollars (Dec. 1973)		
	Level I	Level II	Level III
Annual contract hauling & disposal charges	1,100	1,100	1,500
Average treatment & disposal cost			
- per unit of production ($/1000 hides)	4.90	4.90	6.60
- per metric ton of waste*	31	31	41

Description of Treatment/Disposal Technology:

Level I	Off-site landfill
Level II	Off-site landfill
Level III	Off-site certified hazardous waste disposal facility

Source: SCS Engineers

* On a wet weight basis.

TABLE 58

TREATMENT AND DISPOSAL COSTS
TYPICAL BEAMHOUSE/TANHOUSE FACILITY

	Annual Production (1974)	Location	Manufacturing Process
Typical Plant Characteristics	300,000 equivalent hides/year	Mid- or Southwestern city	Cattlehide chrome tanning

Identification of Wastestream(s)	Potentially Hazardous Constituents	Physical Form	Amount for Treatment/Disposal (wet/dry kg per 1000 hides)
Wastewater sludge	Cr,Pb	Sludge cake	10,000/2,400

Treatment/Disposal Costs/Levels	Dollars (Dec. 1973)			
	Level I	Level II	Level III	
			Alt. 1	Alt. 2
Investment Costs				
Land	4,000	4,000	4,000	4,000
Other	300,000	300,000	300,000	300,000
Total Fixed	304,000	304,000	304,000	304,000
Annual Costs				
Capital Costs	60,400	60,400	60,400	60,400
Operating	18,000	18,000	18,000	18,000
Maintenance	5,000	5,000	5,000	5,000
Energy	2,400	2,400	2,400	2,400
Contract Services	30,000	36,000	36,000	42,000
Total Annualized	115,800	121,800	121,800	127,800
Average treatment & disposal cost				
- per unit of production ($/1000 hides)	390	406	406	426
- per metric ton of waste*	38	41	41	43

Description of Treatment/Disposal Technology:

Level I	Dewater and disposal in off-site landfill
Level II	Dewater and dispose in off-site lined trenches
Level III	Alt. 1: Dewater and dispose in off-site lined trenches Alt. 2: Dewater and dispose in off-site landfill with leachate collection

Source: SCS Engineers

* wet weight basis.

TABLE 59

TREATMENT AND DISPOSAL COSTS
TYPICAL RETAN/FINISHER

	Annual Production (1974)	Location	Manufacturing Process
Typical Plant Characteristics	675,000 equivalent hides/year	Region I or II	Leather retanning & finishing

Identification of Wastestream(s)	Potentially Hazardous Constituents	Physical Form	Amount for Treatment/Disposal (wet/dry kg per 1000 hides)
Trimmings & shavings	Cr	Solid	1,260/540
Unfinished leather trim	Cr,Pb	Solid	114/100
Buffing dust	Cr,Pb	Solid	27/25
Finished leather trim	Cr,Pb	Solid	220/200
Finishing residues	Cr,Pb,Zn	Liquid	150/45
Wastewater screenings	Cr,Pb	Solid	40/10

Treatment/Disposal Costs/Levels	Dollars (Dec. 1973)			
	Level I	Level II	Level III	
			Alt. 1	Alt. 2
Annual contract hauling & disposal charges	12,000	8,000	17,000	9,000
Average treatment & disposal cost				
- per unit of production ($/1000 hides)	18	12	25	13
- per metric ton of waste*	10	20	14	24

Description of Treatment/Disposal Technology:

Level I	Off-site landfill
Level II	Trimmings and shavings sold; other waste to off-site landfill
Level III	Alt. 1: Off-site landfill with leachate collection Alt. 2: Trimmings and shavings sold as a by-product; other waste to off-site landfill with leachate collection

Source: SCS Engineers

* On a wet weight basis.

of waste in a landfill with leachate collection, which will cost $12 per metric ton more than open dumping. The less expensive Level III (Alternative 2) costs are based on the sale of trimmings and shavings and the disposal of other potentially hazardous waste. The large difference in the total cost of these two alternatives arises because blue trim and shavings represent 90 percent of the waste generated by a typical split tannery. The cost per ton of waste actually disposed via Alternative 2 is increased due to the substantially reduced quantity of waste which must be collected and disposed.

A typical leather finisher generates less solid waste than any other category in the industry. Consequently, the annual contract hauling of the disposal costs for all three levels of technology are less than for any other category. However, the cost per metric ton is higher than for most other categories due to the small volumes of waste which must be collected and disposed.

Since wastewater treatment sludge is the only potentially hazardous waste generated by a typical beamhouse/tanhouse facility, all costs shown are the result of sludge treatment and disposal. The cost of treatment and disposal for the most expensive Level III (Alternative 2) is only about 10 percent higher than for Level I. However, since about 90 percent of the total annual cost is the result of sludge treatment, which is the same for all levels of technology, the percentage increase in total cost to go from Level I to Level III technology is not very substantial.

A typical retan/finisher generates the same types of waste in approximately the same quantity as a complete chrome tannery without primary and/or secondary wastewater treatment, except that the complete chrome tannery generates sewer sump sludge. The cost per metric ton for Level II technology for a typical retan/finisher is twice that for Level I because the total quantity of potentially hazardous waste being land disposed in Level II is only approximately 30 percent of that in Level I (due to sale of trimmings and shavings as part of Level II technology). The more expensive Level III technology (Alternative 1) reflects disposal of all potentially hazardous waste, whereas the less expensive Alternative 2 is based on the sale of trimmings and shavings as a by-product and disposal of other waste.

To obtain the total cost of each level of treatment and disposal technology for each category of the tanning industry, the following equation was used:

$$\begin{array}{l}\text{Annual cost of}\\ \text{technology level}\\ \text{for category}\end{array} = \frac{\text{Total annual category production}}{\text{Typical plant production}} \times \begin{array}{l}\text{Annual cost of}\\ \text{technology level}\\ \text{for typical plant}\end{array}$$

Using this relationship, Table 60 was developed to summarize the total costs of treatment and disposal for each category of tannery and illustrates the differences in costs discussed above. For complete chrome tanneries with primary and/or secondary treatment sludge, approximately 90 percent of the total annual treatment and disposal costs are the result of wastewater treatment sludge. For beamhouse/tanhouse facilities, 100 percent of the treatment and disposal costs are the result of wastewater treatment sludge. As a result, approximately 65 percent of the cost of treatment and disposal for the total industry for all three technology levels is a result of wastewater sludge dewatering and disposal.

For complete chrome tanneries without primary and/or secondary wastewater treatment sludge, the total annual treatment and disposal costs for all levels of technology are substantially higher than for other categories such as sheepskin, split tanneries, retan/finishers and leather finishers. This occurs since chrome tanneries produce more leather and generate more potentially hazardous waste than the other categories mentioned.

Another important factor effecting the cost of treatment and disposal technology for the total industry is the ability of complete chrome tanneries (without primary sludge), retan/finishers, and split tanneries to sell blue trim and shavings as a by-product. For these three categories of tanneries, the cost of treatment and disposal is less for Level II (with sale) than Level I (without sale), with the result that the total cost to the industry of Level I technology is virtually the same as for Level II. Similarly, the difference in cost between the most and least expensive Level III technology is primarily a function of whether blue trim and shavings are sold or land disposed.

Using the distribution of production between the various categories observed in 1974, the value added in manufacturing (in December 1973 dollars) during 1974 was $480 million, and total value of shipments was $1,010 million. Thus, the costs of the three levels of treatment and disposal technology compared to the value added in manufacturing and the value of shipments are as follows:

Technology level	Treatment and disposal cost--percent of value added	Treatment and disposal cost--percent of value of shipments
I	0.67	0.32
II	0.68	0.32
III (least costly alternatives)	0.70	0.33
III (most costly alternatives)	0.81	0.38

TABLE 60

ANNUAL TREATMENT AND DISPOSAL COSTS
(Dec. 1973 dollars)

Tannery Category	Level I	Level II	Level III	
			Least costly	Most costly
Chrome w/ sludge	1,524,000	1,702,000	1,629,000	1,702,000
Chrome w/o sludge	675,000	519,000	675,000	675,000
Sheepskin	84,000	84,000	101,000	101,000
Split	60,000	31,000	37,000	411,000
Leather finisher	27,000	27,000	37,000	37,000
Beamhouse/ Tanhouse Facility	812,000	854,000	854,000	896,000
Retan/ Finisher	37,000	25,000	28,000	53,000
Total	3,219,000	3,242,000	3,361,000	3,875,000

Source: SCS Engineers

5.5 Variables Effecting Treatment and Disposal Costs

5.5.1 Size. The economies of scale in tanneries are somewhat limited by the batch process nature of the tanning operation, thus plants in the tanning industry vary widely in size from a few thousand equivalent hides per year to nearly one-half million. This range in production yields a corresponding range in the quantities of potentially hazardous waste generated per 1000 equivalent hides. This, in turn, results in great variations in waste disposal costs. For example, a small tannery with regular, contracted hauling spends much more per metric ton of waste than does a large tannery (the waste is collected under contract hauling whether or not the container is full). Cost for a retan/finisher and a leather finisher reveals the cost of solid waste disposal per metric ton of waste may be three times greater for plants producing relatively small quantities of waste than for those producing more typical quantities. These quantity-related differences were taken into account (to the extent possible) in developing the adjusted costs shown earlier in Table 52 .

5.5.2 Processing Operations. Processing operations also vary greatly from plant to plant within any category of the tanning industry. These variations depend to a large extent upon the type of market to which a given tannery is trying to make its product appear; i.e., a tannery may intentionally generate more waste than normally expected in pursuit of the production of high quality products. No generalizations with respect to the effects of these variations on treatment and disposal costs are possible.

5.5.3 Location. Geographic location of tanneries affects treatment and disposal costs in the sense that costs are higher for those tanneries located in urban areas than for those located in more rural settings. In addition, tanneries in certain areas are able to dispose their waste in municipal facilities where the cost of operating the disposal facilities is included in their taxes. In rural settings, the cost of treatment and disposal is estimated to be approximately $3 per metric ton less than for a typical plant. The adjustments made in Table 52 attempt to account for some of the variations that are found.

If there are no nearby certified hazardous waste disposal facilities or landfills with leachate collection systems, a tannery would incur long distance hauling charges which would increase their disposal cost, or the tannery would have to establish its own disposal site, either on the plant property, or at a remote site. Situations which would require a tannery to haul its waste more than 50 miles to such a site are likely rare and have not been included in the cost estimates presented.

State and local regulations governing potentially hazardous waste disposal impact on only a very few tanneries. Thus, they do not have a significant effect on treatment and disposal costs for the industry.

5.5.4 Method of Dewatering Sludge. The cost of treatment and disposal of sludges is primarily dependent upon the type of dewatering system utilized, the effectiveness of the primary clarification system, and the quantity of wastewater treated. Capital costs for sludge treatment installations varies depending upon the type of system used and the equipment manufacturer. Significant variations in operating costs result from varying chemical usage which depends on the type of dewatering system. The cost of operating different dewatering systems at four tanneries varies from approximately $7,000 to $30,000 per year, depending primarily upon the quantity and types of chemicals used to aid in the dewatering process. Processes associated with sludge dewatering may also vary as a function of the effectiveness of the primary clarifier. No information is available, however, to quantify the effects that this might have on the costs presented for the typical tanneries.

5.6 Sample Cost Calculation

For illustrative purposes, the following computation of the costs of Levels I, II, and III technology are presented for a complete chrome tannery.

5.6.1 Level I Technology: sludge dewatering and off-site landfill

Capital costs. (December 1973 dollars)

Land requirements

Disposal is off-site. Treatment facilities require approximately 0.08 ha (0.2 ac) of land. It is assumed based on contractor experience that land costs are $50,000/ha ($20,000/ac). Land costs are:

0.08 x $50,000 = $4,000

Equipment and installation

Wastes are hauled by a contractor, thus dewatering equipment is the only equipment to be considered. Interviews at four tanneries and contact with equipment suppliers indicated that the average price of an installed sludge dewatering unit (the costs of a filter press, centrifuge and vacuum filter are all taken into account) is $300,000 for the typical plant.

Interest costs, assumed at 10 percent of the capital cost of $304,000 for the sludge dewatering system and the land, is $30,400/year.

Using straight line depreciation for the expected life of the equipment (10 years for $300,000 equipment), depreciation is $30,000/year.

Operating Costs

Labor

1 man, 20 hours per week, 50 weeks per year, operating dewatering equipment at $3.60/hr plus 33 percent fringe benefits equals $4,800/year.

Supervision = 10 percent of labor cost (assumed) = $500

Materials

The cost of materials varies significantly from plant to plant ($2,000-$30,000), depending on the volume of production and the type of dewatering equipment being utilized. It is estimated, based on data collected for five tanneries, that the typical tannery spends $6,700 per year on materials (mostly chemicals).

Maintenance = $5,000 per year, based on tannery information

Insurance and taxes = 2 percent of capital cost = $6,000

Energy = 60 hp x 8 hr/day x 250 day/yr x 0.746 kW/hp x $0.02/kWh = $2,400

Contract services (with disposal in an off-site landfill) = $10/metric ton (see Table 53) x 3,160 metric tons/year = $31,600/year

Total annual costs		$(1973)/year
Capital costs		$ 60.400
Operating		
Labor	$4,800	
Supervision	480	
Materials	6,700	
Insurance and taxes	6,000	18,000
Maintenance		5,000
Energy		2,400
Contract services		31,600
Total annualized		$117,400

Average Treatment and Disposal Costs

per unit of production (1000 equivalent hides)

$$\frac{\$117,400/\text{yr}}{260,000\ \text{eq. hides/yr}} = \$451$$

per metric ton of waste

$$\frac{\$117,400/\text{yr}}{3,160 \text{ metric ton/yr}} = \$37$$

5.6.2 Level II Technology: trimmings and shavings sold, all other waste to certified hazardous waste disposal facility.

Land requirements, equipment, interest, operating, maintenance, and energy costs are all the same as for Level I.

Contract services = $16/metric ton (see Table 52) x 2,834 metric tons/year = $45,300/year

Note that the sale of trimmings and shavings reduces the quantity of waste. Revenues from the sale of trimmings and shavings (approximately $0.01/kg) are not included in the calculations.

Total annual costs	$(1973)/year
Capital costs	$ 60,400
Operating	18,000
Maintenance	5,000
Energy	2,400
Contract services	45,300
Total annualized	$131,100

Average Treatment and Disposal Costs

per unit of production (1000 equivalent hides)

$$\frac{\$131,100/\text{yr}}{260,000 \text{ eq. hides/yr}} = \$504$$

per metric ton of waste

$$\frac{\$131,100/\text{yr}}{2,834 \text{ metric tons/yr}} = \$46$$

5.6.3 Level III Technology: Alternative 1--same as Level II. Alternative 2--trimmings and shavings sold, other wastes to landfill with leachate collection.

Land requirements, equipment, interest, operating, maintenance, and energy costs are all the same as for Level I.

Contract services = $14/metric ton (see Table 52) x 2,834 metric tons/year = $39,700/year

Revenue from sale of trimmings and shavings is not included in these calculations.

Total annual costs	$(1973)/year
Capital costs	$ 60,400
Operating	18,000
Maintenance	5,000
Energy	2,400
Contract services	39,700
Total annualized	$125,500

Average Treatment and Disposal Costs

per unit of production (1000 equivalent hides)

$$\frac{\$125{,}500/\text{yr}}{260{,}000\ \text{eq. hides/yr}} = \$482$$

per metric ton of waste

$$\frac{\$125{,}500/\text{yr}}{2{,}834\ \text{metric tons/yr}} = \$44$$

SECTION 6.0

REFERENCES

1. U.S. Bureau of the Census. 1972 Census of Manufactures. Industry series: Tanning, Industrial Leather Goods; and Shoes. Series MC72(2)-31A. Washington, D.C., U.S. Government Printing Office, 1975. 27 p.

2. Personal communication. E. L. Kilik, Tanners' Council of America, to SCS Engineers, Inc., Reston, Virginia, June 1975 through Feb. 1976.

3. Environmental Protection Agency. Disposal of Hazardous Wastes. Report to Congress. Washington, D.C., U.S. Government Printing Office. 1974.

4. Schaklette, H.T., J.C. Hamilton, J.E. Boernger, and J. M. Bowles. Elemental composition of surficial materials in the conterminous United States. Statistical Studies in Field Geochemistry. U.S. Geological Survey Professional Paper 574-D.

5. Christensen, H.E., ed. Toxic substances list, 1973 ed. Rockville, U.S. Department of Health, Education, and Welfare (National Institute for Occupational Safety and Health). 1973.

6. McKee, J.E. and H.W. Wolf, eds. Water quality criteria. 2nd ed. California State Water Resources Control Board. 1971.

7. Gleason, M., R.E. Gosselin, H.C. Hodge, P.B. Smith. Clinical toxicology of commercial products. 3rd ed. Baltimore, The Williams & Wilkins Co. 1969.

8. Personal communication. W.L. (Pete) Banks, Industrial Advisor, Region VII, Environmental Protection Agency, to SCS Engineers, Inc., Reston, Virginia, Dec. 1975.

9. National Academy of Sciences. Chromium. Washington, D.C. 1974.

10. Leather Facts. 1st ed. Peabody, Massachusetts, New England Tanners Club, 1965. 40 p.

Preceding page blank

11. Versar Inc. Assessment of industrial hazardous waste practices, inorganic chemicals industry. Environmental Protection Agency Contract No. 68-01-2246. Springfield, Virginia. March 1975.

12. Versar, Inc. Assessment of industrial hazardous waste practices: storage and primary batteries industries. Environmental Protection Agency Report (SW-102c). Washington, D.C., U.S. Government Printing Office. 1975.

13. U.S. Department of Health, Education, and Welfare, Public Health Service, Consumer Protection and Environmental Health Services, Environmental Control Administration. Public health service drinking water standards. (rev. 1962). Public Health Services Publication 956. Washington, D.C., U.S. Government Printing Office. 1962. 61 p.

14. Personal communications. A. Pearce and T. Fields, Hazardous Waste Management Division, Office of Solid Waste Management Programs, Environmental Protection Agency, to SCS Engineers, Inc., Reston, Virginia, June 1976 and August 1976.

15. Dobrolyuobovskii, O.K. and A.V. Slavva. Application of new trace nutrients containing chromium in grape culture. Udobr. Uroz. 3:35-37, 1958. (in Russian) (Chem. Abstr. 53:631e).

16. Kurylowicz, B. and S. Gasiorowski. Agrochemical study on calcinated phosphate-containing admixtures of chromium compounds. Prezemysl Chem. 37:797-800, 1958. (in Polish)

17. Koenig. P. Die Reiz-und Giftwirkungen der chromverbindungen auf die Pflanzen. Chem.-Ztg. 35:442-443, 462-463, 1911.

18. Bertrand, D. and A. deWolf. Necessite de l'oligo-element chrome pour la culture de la pomme de terre. C. R. Acad. Sci., Ser. D 266:1494-1495, 1968.

19. Bertrand, D. Va-t-il falloir ajouter le chrome aux oligo-elements devant etre utilises comme engrais complementaires? C. R. Hebd. Seances Adac. Agr. 53:113-115, 1967.

20. Bertrand, D. and A. deWolf. Le chrome, oligoelement dynamique pour les vegetaux superieurs. C. R. Acad. Sci. 26:5616-5617, 1965.

21. Pratt, P.F. Chromium. In Diagnostic Criteria for Plants and Soils. (H.D. Chapman, ed.) Riverside, University of California Division of Agricultural Sciences. 1966. pp 136-141.

22. Personal communication. R. M. Lollar, Tanners' Council of America, to SCS Engineers, Inc., Reston, Virginia, June 1975 through February 1976.

23. Personal communication. M. Jackson, Particle Data Laboratories, to SCS Engineers, Inc., Reston, Virginia, Dec. 1975.

24. Thermal Processing and Land Disposal of Solid Waste Guidelines. Federal Register, 39 (158): 28334, Aug. 14, 1974.

25. Battelle Memorial Institute. Final Report; program for the management of hazardous wastes. Environmental Protection Agency. Richland, Washington, D.C., July 1973.

26. SCS Engineers. Draft Final Report, Vol. II, Case Study Site Reports, Sewage Treatment Solids Disposal by Subsurface Land Application. Environmental Protection Agency. Long Beach, California, December 26, 1975.

27. Fields, T. and A. W. Lindsey, Landfill Disposal of Hazardous Wastes: A Review of Literature and Known Approaches. Environmental Protection Agency Publication SW-165. Washington, D.C., U.S. Government Printing Office, 1975.

28. Personal communication . J.D. Eye, Tanners' Council of America, to SCS Engineers, Inc., Reston, Virginia, June 1975 through February 1976.

29. Personal communication. T. Fields, Jr., Office of Solid Waste Management Programs, Environmental Protection Agency, to SCS Engineers, Inc., Reston, Virginia, October 14, 1975.

30. Personal communication. W. Sanjour, Hazardous Waste Management Division, Office of Solid Waste Management Programs, Environmental Protection Agency, to SCS Engineers, Inc., Reston, Virginia, Jan. 27, 1976.

31. Environmental Protection Agency. Contract No. 68-01-3261, July 9, 1975.

SECTION 7.0

ACKNOWLEDGEMENTS

The conduct of this project was accomplished through the efforts of the staff of SCS Engineers, Inc., Reston, Virginia, and Long Beach, California. E. T. Conrad directed the study with day-to-day project management by Gary L. Mitchell. The Tanners' Council of America provided significant input and assistance during the project.

The project staff is indebted to the U.S. Environmental Protection Agency personnel in the Hazardous Waste Management Division for their continuing interest, advice, and guidance during the entire term of the study. Particular thanks go to Allen C. Pearce, Project Officer, and Timothy Fields, Jr., Acting Program Manager. Thanks are also due to the management and other staff members of the Office of Solid Waste Management Programs, Hazardous Waste Management Division, who reviewed program progress and assisted with constructive suggestions. It is the opinion of the SCS staff that this project has been one of the best examples of EPA/Contractor coordination in the firm's history.

The project could not have been accomplished without the cooperation of the owners and managers of the leather tanning and finishing establishments visited as part of this project. Their interest in the study and willingness to provide necessary information greatly assisted in the acquisition of data.

The Tanners' Council played an important role in the study. As a major subcontractor, the Tanners' Council provided much of the basic industry information, including most of that which is included in the Industry Characterization section. Additionally, the Tanners' Council assisted in the selection of tanneries to be visited and elicited the cooperation of member firms. Special thanks are extended to Dr. Robert M. Lollar and Eugene L. Kilik of the Tanners' Council.

Other subcontractors playing important roles in the project were Dr. J. David Eye and Meryl R. Jackson. Dr. Eye accompanied project teams on several plant visits and provided critical review of several phases of the study and resultant report. Meryl Jackson, the project's air pollution consultant, visited several tanneries and provided advice concerning the effects of air pollution control equipment.

Laboratory analyses were performed by Daylin Laboratories, Inc., of Los Angeles, California. Particular thanks to Henry Espoy and Michael Gordon.

Our appreciation is extended to the other staff personnel of SCS Engineers, Inc., for their efforts during this project. Specifically our thanks to:

- David H. Bauer
- Ronald J. Lofy
- Robert D. Morrison
- Michael W. McLaughlin
- Cindi D. Culkin
- Ginny B. Paul
- Marcia Saunders
- Dixi A. Russo
- Thomas A. Wimmer

SECTION 8.0

GLOSSARY

Back	A portion of hide formed by cutting the hide longitudinally along the backbone, then trimming off head and belly, leaving a bend and shoulder.
Bate	The treatment of hides with enzymes prior to tanning. Bating removes the lime used in the hair removal processes and the enzymes prepare the hide for the tanning solution by destroying most of the remaining undesirable constituents in the hide such as hair roots and pigments.
Beaming	The traditional name for the processes of flesh and hair removal from skins and hides to be tanned into leather. Beaming operations also include one or more soaking steps to loosen or dissolve hair.
Bend	A sole leather back with the shoulder trimmed off.
Buffing	A light sanding operation applied to the grain or underside of leather and also to splits. Buffing smooths the grain surface and improves the nap of the underside of the leather.
Buffing dust	Small pieces of leather removed in the buffing operation. Buffing dust also includes small particles of abrasive used in the operation and is of a coarse powder consistency.
Blue	The state or condition of hides subsequent to chrome tanning and prior to retanning. Hides in this stage of processing are characteristically blue in color.
Coloring	The dying of leather to the desired color and shade.
Dry Milling	The rotating of leather in a large wooden drum with no added chemicals or water. Dry milling softens the leather.
Equivalent Hides	A statistical term used by the Tanners' Council of America to relate the production of tanneries using various types of raw materials. An

equivalent hide is represented by 3.7 m^2 (40 ft^2) of surface area and is the average size for a cattlehide.

Fatliquor : The agitation of tanned hides in oils or related fatty substances. Fatliquoring regulates the softness and pliability of the leather and also contributes to its tensile strength.

Finishing : The application of materials to the grain surface of leather to provide abrasion and stain resistance and to enhance color. Finishes are usually sprayed or rolled onto the leather followed by drying. Finishes may be either water or organic solvent based and normally more than one finish coat is applied to the leather. Other operations considered as part of finishing include plating and embossing.

Fleshing : The mechanical removal of flesh and fatty substances from the underside of a hide prior to tanning. In the case of sheepskin tanning, fleshing is often accomplished after the tanning process.

Fresh Hide : Hide that has not been preserved by brining or salting. Fresh hides are usually received at tanneries within 24 to 48 hours of slaughter.

Grain Side : The outermost portion of a hide having the characteristic natural graining associated with the outer surface of a hide or skin.

Head : That part of the hide which is cut off at the flare into the shoulder, i.e., the hide formerly covering the head of the animal.

Hide : The skin of a relatively large animal, at least the size of mature cattle.

Mechanical Conditioning : A generic term representing a number of mechanical operations used to alter the physical properties of the leather. Operations included are staking, dry milling, and buffing.

Pickle : The transforming of hides into an acid environment prior to tanning. The hides are agitated in a solution of sulfuric acid and sodium chloride to reduce the pH of the hides.

Plating : The pressing of grain leather to smooth its surfaces. Plating may also be done with an embossing plate which imprints textured effects into the leather surface.

Retanning : A second tanning process utilizing either the natural tanning materials (chromium or vegetable extracts) or synthetic tanning agents. Retanning imparts specialized properties to the leather.

Shaving : 1) An abrasive, mechanical action used to correct errors in splitting and thus yield a uniformly thick grain side or split. 2) The waste products generated during the shaving operation. These are essentially small pieces of the tanned hide, which are approximately the size of wood shavings.

Shoe Leather : This term embraces a variety of leathers. Included are: (1) Sole Leather, made from cattlehides and to a small extent from horsehides and buffalo hides, which comprises both the heavier grade, used for outer soles of shoes and the lighter grades and offal (heads, shoulders, and bellies), used to a greater or less extent for heels, insoles, toecaps, etc.; (2) Upper Leather, made principally from calfskins, goatskins, cattlehides, horsehides, and other classes of animal skins, going into shoe uppers; and (3) miscellaneous shoe leathers, including welting, lining stock, tongue stock, facing stock, etc.

Shoulder : That part of the hide between the neck and the main body of the hide.

Side : A one-half of a hide produced by cutting the hide down the backbone. Normally done to facilitate processing using smaller equipment than would be required if full hides were processed.

Skin : The pelt or skin of animals smaller than mature cattle, e.g., pigskin, sheepskin, calfskin.

Split : 1) The operation of separating a hide into two layers, a grain side and a flesh side ("split"). The process is accomplished on a splitting machine similar to a horizontal band saw which slices the hide through its thickness leaving a relatively uniformly thick outer, or grain side, and a split of varying thickness.
2) The underside layer of a hide after splitting. The split has no grain characteristics and is often used for the production of suede leather.

Staking : The mechanical massaging of leather to soften it and make it more pliable.

Syntan : Synthetic tanning materials, generally used in combination with vegetable, mineral or formaldehyde tannages. Syntans are almost exclusively used in retanning rather than tanning operations.

Tanning : The process of converting a hide or skin into leather by soaking it in a tanning solution made of vegetable extracts, alum, formaldehyde, or metals such as chromium or zirconium.

Tear-Offs : Small pieces of leather, less than half a skin, which are torn from a skin during tanning operations.

Trimming : 1) The removal of the ragged edges and inferior portions of hides and skins either before or after tanning. Trimming is normally accomplished by workers using knives.
2) The hide or leather scraps produced during the trimming operation.

SECTION 9.0

APPENDICES

Appendix A
Alphabetical List of Establishments in the Leather Tanning and Finishing Industry

A

A & B Tanning Corp.
101 Belmont Street
Brockton, MA 02401

A.L.M. Corp.
2-18 Mott Street
Newark, NJ 07105

Acme Sponge & Chamois Co., Inc.
855 E. Pine Street
Tarpon Springs, FL 33580

Adams Tanning Corp.
126 South Street
P. O. Box 5115
Newark, NJ 07105

Admiral Leather Corp.
203 Jansen Avenue
Johnstown, NY 12095

Algy Leather Co., Inc.
15 Mill Street
Danvers, MA 01923

Allen Leather, Inc.
62 Foundry
Wakefield, MA 01880

Bona Allen, Inc.
115 E. Main
Buford, GA 30518

Alliance Leather Finishing Co.
4 Union Street
Peabody, MA 01830

Allied Leather Co.
324 E. Eleventh Street
Wilmington, DE 19899

L. Alperin Co.
17 Hale Street
Haverhill, MA 01830

Wm. Amer Co.
215 Willow Street
Philadelphia, PA 19123

American Lace & Leather
Co., Inc.
P. O. Box 121
Richmond, VA 23201

American Leather Mfg. Co.
2195 Elizabeth Avenue
Rahway, NJ 07065

Amoskeag Leather Finishing,
Inc.
S. Commercial Street
Manchester, NH 03101

Arizona Tanning Co.
P. O. Box 788
Chandler, AZ 85224

Armira Corp.
1113 Maryland Avenue
Sheboygan, WI 53081

Armira Corp.
Highway 18, North
Bolivar, TN 38008

Aztec Leather Corp.
195 McWhorter
Newark, NJ 07105

Preceding page blank

B

BTH Tanning Corp.
122 W. 8th Avenue
Gloversville, NY 12078

Badger State Tanning Corp.
305 N. 25th Street
Milwaukee, WI 53233

Barbour Welting Co., Inc.
932 N. Montello
Brockton, MA 02403

A. Barth Leather Co.
(Div. of Caldwell Lace Leather)
New Albany, IN 47150

Beggs & Cobb Corp.
139 Lynnfield
Peabody, MA 01960

Beinowitz & Son, Inc.
76 S. 8th Street
Brooklyn, NY 11211

M. Berger Trading
495 Main Street
Gloversville, NY 12078

Berlin Tanning Co., Inc.
235 S. Wisconsin
Berlin, WI 54923

Besse, Osborn & Odell, Inc
Spring Street
Clinton, ME 04927

Bettencourt Tanning Co., Inc.
340 Merrimack
Lawrence, MA 01843

Beverly Leather Finishing Co.
12 Hanson
Salem, MA 01970

Blackhawk Tanning Co.
1000 W. Bruce
Milwaukee, WI 53204

Blank Sons & Co.
1530 Chestnut
Philadelphia, PA 19102

Blue Hen Finishing Co.,Inc.
E. 7th Street
Wilmington, DE 19801

Blueside Co.
Spur 759 at Florence Road
P. O. Box 383
St. Joseph, MO 64502

Bob-Kat Leather Co.
Rt. 166 Main
Peabody, MA 01960

Bond Leather Co., Inc.
125 Summit
Peabody, MA 01960

Boone Enterprises, Inc.
Box 266
Boone, IA 50036

Boyn-Tan Leathers, Inc.
166 Main
Peabody, MA 01960

Brezner Tanning Co.
Penacook, NH 03301

Brezner Tanning Co.
(Div. of Allied Leather)
Boscawen, NH 03301

Brindis Leather Co., Inc.
Main Street
Canton, ME 04221

Brindis Tanning Co., Inc.
59 Washington
Haverhill, MA 01830

W. D. Byron & Sons, Inc.
Williamsport, MD 21795

C

Calanpro, Inc.
2466 Van Ness Avenue
P. O. Box 7166
National City, CA 92050

Caldwell Lace Leather Co.
Auburn, KY 42216

California Tanning Co.
1905 Shenandoah Avenue
St. Louis, MO 63104

Calnap Tanning Co.
P. O. Box 2190
Napa, CA 94558

Camden Tanning Corp.
116 Washington
Camden, ME 04843

Carr Leather Co., Inc.
500 Boston
Lynn, MA 01903

Cayadutta Tanning Co., Inc.
98 Harrison
Gloversville, NY 12078

Chestnut Operating Co.
2nd & Chestnut
Reading, PA 19602

Chic Leather Co., Inc.
84 Wingate
Haverhill, MA 01830

Chicago Tanning Co.
1500 Cortland
Chicago, IL 60622

Cincinnati Kid, Inc.
920 West Ninth
Upland, CA 91786

Clark's Leather Splitting Co., Inc.
36 West Street
Gloversville, NY 12078

Coey Tanning Co.
Wartrace, TN 37138

Colonial Tanning Corp.
8-10 Wilson Street
Gloversville, NY 12078

The Colorado Tanning &
Fur Dressing Co.
1787 S. Broadway
Denver, CO 80210

Comet Leather Finishing
Co., Inc.
Fifth Street
Peabody Industrial Park,
MA 01960

Concord Leather & Skins
Corp.
Fifth Street
Peabody Industrial Park,
MA 01960

Conneaut Leather, Inc.
W. Adams
Conneaut, OH 44030

Coronet Leather Finishing,
Corp.
201 Central Street
Georgetown, MA 01830

Corpro Industries
Lubbock, TX 79408

Creese & Cook Co.
33 Water Street
Danvers, MA 01923

Crescent Leather Finishing
Townsend Avenue
Johnstown, NY 12095

Crown Leather Finishing Co.
422 N. Perry
Johnstown, NY 21095

Cudahy Tanning Co.
5043 S. Packard
Cudahy, WI 53110

Cui
4400 Brighton Blvd.
Denver, CO 80202

E. Cummings Leather Co., Inc.
10 High Street
Lebanon, NH 03766

The Custom Tannery, Inc.
1170 Martin Avenue
Santa Clara, CA 95050

D

Damascus Tanning Co.
Box 470
Coudersport, PA 16915

W. Dardano & Sons, Inc.
37 Grand
Canton, MA 02021

Donnell & Mudge, Inc.
151 Canal
Salem, MA 01970

Drew Tanning of Brockton, Inc.
62 Watson
Brockton, MA 02401

Dudley Leather Co.
244 Broad
Lynn, MA 01901

E

Eagle Ottawa Leather Co.
200 N. Beechtree Road
Grand Haven, MI 49417

Eastern Tanning Co.
41 Hardy
Peabody, MA 01960

Eberle Tanning Co.
Church Street
Westfield, PA 16950

J. H. Elliott Leather Co.
356 Adams
Newark, NJ 07105

Ellithorp Tanning Co., Inc.
9-19 Grove
Gloversville, NY 12078

Elton Leather Corp.
47 Spring
Gloversville, NY 12078

Embossing Corp. of America
12 Winter Street
Peabody, MA 01960

F

Fashion Tanning Co., Inc.
6 Van Road
Gloversville, NY 12078

Fashion Tanning Co.
126 W. Fulton
Johnstown, NY 12095

Fermon Tanning Co.
11-27 Walnut
Peabody, MA 01960

Fidelity Leather Mfg.
Co., Inc.
80 Lowell
Peabody, MA 01960

Flagg Tanning Corp.
624 W. Oregon
Milwaukee, WI 53204

Flavorland Industries, Inc.
Hide Processing Division
P. O. Box 190
Sergeant Bluff, IA 51054

Florida Tanning & Sponge
Co., Inc.
S. Walton
Tarpon Spring, FL 33589

J. Flynn & Sons
80 Boston Road
Salem, MA 01970

S. B. Foot Tanning Co.
Red Wing, MN 55066

Foster Leather Co.
R-51 Canal
Salem, MA 01970

L. J. Frebel Sons Co., Inc.
499 Main
Belleville, NJ 07109

Frielich Leather Corp.
Industrial Park
Haverhill, MA 01830

Frontier Leather Co.
1210 E. Pacific
P. O. Box 502
Sherwood, OR 97140

Frontier Tanning Co.
Box 122 Star Rt.
Anchorage, AK 99502

G

A. F. Gallun & Sons Corp.
1818 N. Water
Milwaukee, WI 53201

Garden State Tanning
Fleetwood, PA 19522

A. L. Gebhardt Co.
226 N. Water
Milwaukee, WI 53202

Geilich Tanning Co.
491 W. Water
Taunton, MA 02780

General Leather Finishing Co.
32 Varney
Salem, MA 01970

General Split Corp.
5050 S. Second Street
P. O. Box 491
Milwaukee, WI 53201

General Splitting Co.
28 Winter
Peabody, MA 01960

Genesco
Fort Worth, TX 76101

W. Gibb Leather Co.
54th & Grays Avenue
Philadelphia, PA 19143

Gloversville Embossing
Co., Inc.
28-30 E. 11th Avenue
Gloversville, NY 12078

Glove City Abrading Co.,
Inc.
3 Harrison
Gloversville, NY 12078

Gloversville Leather Co.,
Inc.
318 W. Fulton
Gloversville, NY 12078

Gnecco & Grilk Tanning
Corp.
80 Foster
Peabody, MA 01960

Golden Wool Co.
3001 Sierra Pine
Los Angeles, CA 90023

O. F Goldsmith Leather Co.
63 Proctor
Salem, MA 01970

Goldstein Leather Co.
New Jersey R. R. Avenue
Newark, NJ 07102

Goliger Leather Co.
5 Hill
Gloversville, NY 12078

Granite State Leather, Inc.
Fairmount
Nashua, NH 03060

Great Lakes Tanning Co.
4100 W. Aver Avenue
Milwaukee, WI 53216

Greene Tanning Corp.
Milton Mills NH 02852

Wm. Greiner Co.
2252 N. Elston Avenue
Chicago, IL 60614

Gunnison Bros., Inc.
Box 166
Girard, PA 16417

Gunther Tanners & Master Taxidermist
3200 Mariposa
Denver, CO 80202

Gutenstein & Co., Inc.
440 Frelinghuysen Avenue
Newark, NJ 07114

Gutman & Co.
1511 Webster Avenue
Chicago, IL 60614

H

H. D. C. Leather Co., Inc.
101 Foster
Peabody, MA 01960

H. L. S. Leather Co., Inc.
122-124 W. 8th Avenue
Gloversville, NY 12078

Hallmark Leather Co., Inc.
20 Walnut
Peabody, MA 01960

Harmony Buffing Co., Inc.
7 1/2 Mason
Box 428
Peabody, MA 01960

Harris & Tipograph, Inc.
725 Broadway
New York, NY 10003

A. Harvey Leather Finishing, Inc.
500-B Kennedy Blvd.
Somerdale, NJ 08083

Henry Leather Co.
150 Main
Peabody, MA 01960

Hermann Oak Leather Co.
4050 N. First
St. Louis, MO 63147

Hickey Leather Co.
Brigham Hill Road
Grafton, MA 01519

Highland Leather Corp.
Box 248
Sebring, FL 33870

Horween Leather Co.
2015 Elston Avenue
Chicago, IL 60614

E. F. Houghton & Co.
303 W. Lehigh Avenue
Philadelphia, PA 19133

Howes Leather Co., Inc.
Curwensville, PA 16833
and Frank, WV 24937

Hoty & Worthen Tanning Corp.
Railroad
Haverhill, MA 01830

Huch Leather Co.
W. Horner
Chicago, IL 60622

I

Ideal Finishing Co.
55-61 Boston
Salem, MA 01970

Ideal Leather Finishers
92-94 Spring
Gloversville, NY 12078

Independent Leather Mfg., Corp.
315-329 S. Main
Gloversville, NY 12078

Irving Tanning Co.
Main
Hartland, MA 04943

J

JEC Tanning Co.
111 Foster
Peabody, MA 01960

J. B. F. Industries, INc.
41 W. Eleventh Avenue
Gloversville, NY 12078

J. P. Tanning Co.
373 River Road
Haverhill, MA 01830

Jansha Tanning Co.
1355 State Avenue
Marysville, WA 98270

Johnstown Leather, Inc.
Railroad
Johnstown, NY 12095

S. Jonas Leather Mfg., Co.
174 Broadway
Brooklyn, NY 11211

R. Jones & Co., Inc.
5 Burr
Gloversville, NY 12078

Jones & Naudin Leather Corp.
87 S. Main Street
Gloversville NY 12078

Jonish Leather Mfg., Co.
55 Mercer
New York, NY 10013

K

Karg Bros.
6-20 E. Fulton
Johnstown, NY 12095

Kirstein Leather Co.
72 Main
Saco, ME 04072

Kroy Tanning Co., Inc.
18 Goodhue
Salem, MA 01970

L

The Lackawanna Leather Co.
Richard Mine Road
Wharton, NJ 07885

The Lackawanna Leather Co.
California

The Lackawanna Leather Co.
North Carolina

Lackawanna of Omaha
2420 Z Street
Omaha, NB 68107

Lannon Mfg. Co., Inc.
W. Lincoln
Tullahoma, TN 37388

Law Tanning Co.
401 S. 74th Street
Milwaukee, WI 53204

A. C. Lawrence
(Div. of Estech)
25 & Central Avenue
Ashland, KY 41101
& Rt. 128,
Peabody, MA 01960
& Winchester, NH 03270
& Hazelwood, NC 28738
& Newport, TN 37821
& S. Paris, ME 04281

Lawrence Leather Finishing Corp.
15 Union
Lawrence, MA 01840

Leach-Heckel Leather Co.
72 Flint
Salem, MA 01970

Leather Finishers, Inc.
222 Verona Avenue
Newark, NJ 07104

Leather Finishing Corp.
2615 W. Greves
Milwaukee, WI 53233

The Leather Group, Inc.
10 Burr
Gloversville, NY 12078

Leather Line Co.
122 S. Main
Gloversville, NY 12078

Leavitt-Berner Tanning Corp.
114 N. Perry
Johnstown, NY 12095

Legallet Tanning Co.
1099 Quesada Avenue
San Francisco, CA 94124

Liberty Dressing Corp.
Harrison Street
Gloversville, NY 12078

Liberty Rawhide
663 W. Hobbie
Chicago, IL 60610

Loewengart & Co., Inc.
Mercersburg, PA 17236

S. Lojko & Sons, Inc.
23 Oak
Peabody, MA 01960

Lomelis Bros. Splitting Co.
Shetland Industrial Park
Salem, MA 01970

Los Angeles Tanning Co.
4101 Whiteside
Los Angeles, CA 90063

M

Masassee-Block Tanning Co.
1300 4th Street
Berkeley, CA 94710

Maro Leather Company
831 Broadway
Newark, NJ 07104

Marshall Leather Finishing
Co., Inc.
45 Wooster
New York, NY 10013

Masino Leather Co.
41 Hardy
Peabody, MA 01960

Mason Tanning Co., Inc.
4 Water
Salem, MA 01970

Mass Split, Inc.
55 Walnut
Peabody, MA 01960

Master Inc.
287 E. 6th
St. Paul, MN 55101

N. H. Matz Leather Co.,
Inc.
119 Foster
Peabody, MA 01960

McAdoo & Allen, Inc.
S. Hellertown
Quakertown, PA 18951

McLeod Leather & Belting
Co., Inc.
P. O. Box 2310
910 Scott Avenue
Greensboro, NC 27402

Meeten & Beghardt, Inc.
1775 Egbert Avenue
San Francisco, CA 94124

R. E. Meyer & Sons, Inc.
5009 Grand Avenue
N. Bergen, NJ 07047

Michael's Finishing Co.
9 Howley
Peabody, MA 01960

Mid-Tenn Tanning Co.
Industrial Parkway
Shelbyville, TN 37160

Middlesboro Tanning Co.
of Del., Inc.
P. O. Box 189
Middlesboro, KY 40965

Middletown Leather Co.,
Inc.
200 Valentine Street
Hackettstown, NJ 07840

Midwest Tanning Co.
1200 Davis Avenue
S. Milwaukee, WI 53172

Missouri Belting
1021 S. Grand Blvd.
St. Louis, MO 63104

Moench Tanning Co., Inc.
P. O. Box 389
Gloversville, NY 12078

G. Moser Leather Co.
Silver
New Albany, IN 47150

Mucci Bros , Inc.
605 N. Third
Newark, NJ 07107

Muir & McDonald
100 Levens
Dallas, OR 97338

Murray Bros Tanning Co., Inc.
215 Salem
Woburn, MA 01801

N

National Leather Co.
465 E. 147th Street
Bronx, NY 10455

National Rawhide Mfg. Co.
1464 W. Webster Avenue
Chicago IL 60614

Nelson & Sons, Inc.
625 Humble Avenue
San Antonio, TX 78225

R. Newmann & Co.
300 Observer Highway
Hoboken, NJ 07030

S. Newmann Tannery
91 Colden
Newark, NJ 07103

New Braunfels Leather Co., Inc.
197 S. Seguin Avenue
New Braunfels, TX 78130

Newbury Tanning Corp.
12 Federal
Newburyport, MA 01950

N. J. Tanning Co., Inc.
410 Frelinghuysen Avenue
Newark, NJ 07114

Norwich Leather Co.
70 Brookside Avenue
Borckton, MA 02403

Nuco Leather Finishing Co., Inc.
646 Grove, Rt. 1
Elizabeth, NJ 07200

O

Ocean Leather Corp.
42 Garden Street
Rahway, NJ 07065

Osmo Tanning & Mfg.
(Div. of Ranred Corp)
Box 151
Spartansburg, PA 16434

P

Page Belting Co.
Commercial
Concord, NH 03301

E. W. Parks Co.
70 Beacon
Worcester, MA 01608

Parsons Tanning Co.
Parsons, WV 26287

Pearse Leather Co., Inc.
7 Kershaw Avenue
Hampton, NH 03842

Peerless Tanning Co.
24 Briggs
Johnstown, NY 12095

Pfister & Vogel Tanning Co.
1531 N. Water Street
Milwaukee, WI 53201

Phenny-Smidt Leather Co.
21 Caller
Peabody, MA 01960

Pierini Tanning & Dyeing Corp.
28 Paris
Rahway, NJ 07105

Pioneer Tanning Co., Inc
3 Tremont Place
Salem, MA 01970

W. B. Place & Co.
368 W. Sumner
Hartford, WI 53027

Plumer Leather Finishing Co.
1678 Leonard
Cleveland, OH 44113

Poetsch & Peterson
325 S. Maple Avenue
San Francisco, CA 94080

Pownal Tanning Co.
N. Pownal, VT 05260

Prime Tanning Co., Inc.
Sullivan
Berwick, MA 03901

Printz Tanning Co., Inc.
1530 Chestnut
Philadelphia, PA 19102

Progressive Leather Co.
16 Fowle
Woburn, MA 01801

R

Rapco Leather Co.
1010 Davis Road
S. Milwaukee, WI 53172

Raser Tanning Co.
757 Prospect Road
Ashtabula, OH 44004

Remis Industries
(Div. of Beggs & Cobb)
22-24 Johnson
Rahway, NJ 07105

Renco Leather Finishing
Co., Inc.
Harris Street
Gloversville, NY 12078

Rex Leather Finishing
Corp.
119 Foster
Peabody, MA 01960

Richard Leather Co., Inc.
9 Webb
Salem, MA 09170

J. J. Riley Co.
228 Salem
Woburn, MA 01801

Risedorph, Inc
14o W. 8th Avenue
Gloversville, NY 12078

Jos. Roller Co., Inc.
500 Chancellor Avenue
Irvington, NJ 07111

A. H. Ross & Son Co.
1229 N. North Branch
Chicago, IL 60622

R. Rueping Leather Co.
96 Doty
Fond du Lac, WI 54935

R. Rulison & Son, Inc.
Charles Street
Johnstown, NY 12095

S

Salem Embossing Co.
12 Hanson
Salem, MA 01970

Salem Suede, Inc.
9 Irving
Salem, MA 01970

Salz Leather
1040 River Street
Santa Cruz, CA 95060

Schaffell Tanning Corp.
W. Fulton
Gloversville, NY 12078

Scholze Tanning
3100 St. Elmo Avenue
Chattanooga, TN 37408

H. Schwarz Leather Co., Inc.
Garden Pl. & River Road
Edgewater, NJ 07020

Seakas Leather Co.
4 Eagan Place
Peabody, MA 01960

Seal Tanning
(Div. of Beggs & Cobb)
Commercial Street
Manchester, NH 03101

Seidel Tanning Corp.
602 W. Oregon
Milwaukee, WI 53204

Seton Leather Co.
849 Broadway
Rahway, NJ 07104

Shawmut Tanning Corp.
45 Walnut
Peabody, MA 01960

Sheepskin Lining Co., Inc.
10 Cayadutta
Gloversville, NY 12078

Sidney Tanning Co.
218 N. Ohio Avenue
Sidney, OH 45365

Sierra Pine Tanning
3001 Sierra Pine Avenue
Los Angeles, CA 90023

Simco Leather Corp.
99 Pleasant Avenue
Johnstown, NY 12095

Sirois Bros., Inc.
73 Lowell
Peabody, MA 01960

Slip-Not Belting Corp.
432 E. Main
Kingsport, TN 37662

Spanish-American Skin Co.
11-13 Cayadutta
Gloversville, NY 12078

Stahlbrand Leather Co.
Rfd. 3
River Road
Bow, NH 03301

Star Leather
6-8 Division
Gloversville, NY 12078

Strauss Tanning Co., Inc.
145 Lowell
Peabody, MA 01960

Suncook Tanning Corp.
Pittsfield, NH 03263

Sunnyside Tannery
12687 S. E. Sunnyside Road
Clackamas, OR 97015

Superior Hat Leather Co.
119 Foster
Peabody, MA 01960

Sure-Tan, Inc.
1470 W. Webster
Chicago, IL 60614

C. Swartzburg Leather Co.
150 Main
Peabody, MA 01960

Sweet Home Tanning Co.
P. O. Box 454
Sweet Home, OR 97386

G. Swoboda & Son, Inc.
1027 N. Bodine
Philadelphia, PA 19123

T

Tanners Degreasing Co., Inc.
325 Montvale Avenue
Woburn, MA 01801

Tanzer Leather Co.
4 Union
Peabody, MA 01960

Tennessee Tanning Co., Inc
915 Atlantic
Tullahoma, TN 37388

Thiele Tanning Co.
123 N. 27th
Milwaukee, WI 53208

Thru-Blu, Inc.
501 Malden
S. St.Paul, MN 55075

Travel Leather Co., Inc.
42 Walnut
Peabody, MA 01960

Twin City Leather Co., Inc
River Road
Gloversville, NY 12078

U

Uber Tanning Company
Owatonna, MN 55060

United Rawhide Mfg. Co.
1644 N. Ada
Chicago, IL 60622

United Tanners, Inc.
9 Orchard Street
Dover, NH 03820

V

Vernon Leather Co., Inc
2890 Sierra Pine Avenue
Los Angeles, CA 90023

Victory Tanning Corp.
123 Upton
Peabody, MA 01960

Virginia Oak Tannery, Inc.
Box 511
Luray, VA 22835

Volunteer Leather Co.
Kefauver Drive
Milan, TN 38258

W

Walnut Finishing Co.
57 Grove
Salem, MA 01970

Waterboro Co.
Depot Street
Waterboro, ME 04087

Weil & Eisendrath Co.
2221 Elston Avenue
Chicago, IL 60614

Weldon Leather Co.
Benicia Industrial Park
P. O. Box 583
Benicia, CA 94510

Wells Tanning Inc.
633 W. Center Street
N. Salt Lake, UT 84054

Western Leather Products
Corp.
904 E. Pearson
Milwaukee, WI 53202

Western Tanning Co.
P. O. Box 44
Delta, CO 81416

White Eagle Rawhide Mfg.
Co.
1652 N. Throop
Chicago, Il 60622

Whitehall Leather Co.
Lake
Whitehall, MI 49461

R. S. Widen Co.
Ashton Avenue
N. Adams, MA 01247

Wilmington Enameling Co.
P. O. Box 66
Wilmington, DE 19899

Wilton Tanning Co.
Box 55, Rt. 2
E. Wilton, ME 04234

Wisconsin Leather Co.
1830 S. Third Street
Milwaukee, WI 53204

Woburn Degreasing Co.
134 Bedford Road
Woburn, MA 01801

Woverine World Wide Co.
9341 Courtland Drive
Rockford, MI 49341
& 501 Musser
Muscantine, IA 52761

Wood & Hyde Leather Co.
69 Wood
Gloversville, NY 12078

Wyaocki Taxidermy & Leather
2451 N.W. 58th Street
Seattle, WA 98107

Z

C. E. Zimmerman & Co.
2756 Toulouse
New Orleans, LA 70119

Appendix B
Outline of Procedures for Field Visits, Sample Collection, and Sample Analysis

Development of Field Manual. Early in the project, a field manual was developed for use by the project teams visiting tanneries. The purpose of the manual was to provide general direction to field teams prior to, during, and after their plant visits. It contained general instructions, data collection forms, and sample analysis forms. This material ensured that the field engineers collected complete information and enabled presentation of the information in a uniform manner.

A plant visit outline was presented in the manual. It listed the general steps to be followed by field teams before, during, and after a plant visit. The outline ensured that all field teams followed the same general procedures in arranging for their visits and that all necessary coordination between SCS, its subcontractors, and EPA had been accomplished. The plant visit outline included the following steps:

1. Group the selected plants geographically to reduce travel time and costs.

2. Telephone the tanneries to reintroduce the project (they have already been contacted by TCA), arrange for a convenient visit date, assign a plant code number. Coordinate with TCA when problems arise; e.g., an important tannery is reluctant to cooperate.

3. Develop travel itineraries and advise EPA and TCA of travel plans as soon as possible. Send copies of itineraries to Dr. Eye and Meryl Jackson when appropriate.

4. Send a visit confirmation letter or telephone the tannery a few days prior to the planned visit to remind them of the planned visit.

5. Complete the plant visit. Fill out the plant visit data collection form as well as sampling and analysis forms during the visit and dictate supplementary memorandum for material that does not lend itself to notation on the forms. Complete the disposal site visit form when a disposal site is visited.

Proceding page blank

6. Send a letter to each plant visited thanking them for their cooperation in the project and transmitting a typed copy of the plant visit data form to the plant for their comments, corrections, and for their general information. Also send copies to the EPA Project Officer and TCA.

7. If samples were obtained at the plant, send copies of the sample analyses to the plant upon receipt from the analytical laboratory.

During each plant visit, the plant visit data collection form was completed. Information areas included in the data form are as follows:

1. Identification--plant and field team.

2. Processing

   - Production information
   - General processing block diagram
   - Specifics on the various types of operations conducted at the plant. Space was provided for detailed block diagrams in order to show movement of hides and sources of process solid wastes.
   - Information concerning by-product handling, including a by-product sale summary tabulation.

3. Waste material

   - A sketch of wastewater pretreatment or treatment facilities, plus methods used by the plant to handle wastewater sludges.
   - Information concerning air pollution control devices.
   - A listing of chemical containers coming into the plant by chemical type, container size, number received per month, and method of disposal.
   - A lengthy section concerning solid waste handling and disposal. It included the names and addresses of contract services, storage and handling equipment within the plant, energy consumption for solid waste handling, labor costs, and equipment and land costs for on-site treatment and disposal.
   - A sampling summary table.
   - A process solid waste summary table (these latter two tables provided a ready reference to the types and quantities of solid waste produced within the plant and information concerning the samples collected).

A similar form was developed for the collection of information at disposal sites accepting tannery solid wastes. This form includes the following:

- Identification information
- Description of the disposal site
- The number of tanneries served by the disposal site
- The number and type of equipment used
- General operating procedures
- Number of workers
- Measures used for environmental pollution control
- Problems and suggestions as to how disposal operations could be improved

Sampling Instructions. Particular emphasis was placed on providing complete instruction for sampling tannery wastes. By following these instructions, the project could be assured that the samples would be representative of tannery wastes within the limitations of the sampling program and that the samples would have a minimum of contamination and degradation during storage and shipment to the laboratory. Separate sections of the sampling instruction were devoted to:

- Sampling equipment and materials
- Sampling procedures
- Packing and shipment of samples

Pages from the field engineer's manual concerning sampling instructions and the sampling and analysis data form are included for the benefit of the reader.

SCS ENGINEERS

SAMPLING INSTRUCTIONS

Introduction

The purpose of the field sampling program is to obtain representative solid waste samples from each of the leather tanning and/or finishing plants visited. The accuracy and care taken during the sampling cannot be overemphasized--the accuracy of the analyses depend to a large extent on the degree to which the sample is representative of the whole from which it is taken. Refer to Table 1, Preliminary Sampling Handling Summary, for examples of sample sources and handling procedures.

Sampling Equipment and Materials

The following materials will be required by the field sampling team.

1. One copy of "SCS Field Manual"
2. Styrofoam-lined corrugated shipping cartons and sufficient blue ice for shipping samples requiring refrigeration. The blue ice should be frozen prior to obtaining the samples.
3. Adequate supply of glass, one liter wide-mouth bottles and lids.
4. pH paper (wide range and 7-10 and 10-13 ranges) to determine the approximate pH of the samples taken.
5. Adhesive mailing labels and black waterproof marking pen
6. Two rolls of fiber packing (strapping) tape
7. Notebooks for field notes and calculations
8. Supply of sampling and analysis data forms and sample inventory forms
9. Some type of rubber footwear or heavy boots
10. Half gallon plastic pitcher for taking sludge samples

TABLE I

PRELIMINARY SAMPLING SUMMARY

Sample Source Location/Operation	Type of Sample	Preservation	Analyses to be Conducted
Hide cellar	Floor sweepings & trimmings	4°C for fresh hides only, otherwise none	Metals, Pesticides, and Phenols
Beamhouse	Fleshings		
	Fresh hides	4°C	Metals and Pesticides
	Salted hides	None	Metals and Pesticides
	Limed (unhaired) hides	4°C if more than 48 hrs. in transit to lab	Metals, Pesticides and Sulfides
	Hair removal		
	Hair-save residue	4°C	Metals, Pesticides and Sulfides
	Hair-pulp residue	4°C	Metals, Pesticides and Sulfides
	Trimmings		
	Fresh hides	4°C	Metals and Pesticides
	Brined or salted hides	None	Metals and Pesticides
	Limed (unhaired) hides	4°C if more than 48 hrs. in transit to lab	Metals, Pesticides and Sulfides
	Floor sweepings	None	Metals, Phenols, and Pesticides
Tanhouse	Tanning residue	None	Metals, Phenols, Cyanides, Sulfides, and Pesticides
	Splits and shavings	None	Metals

TABLE I (Continued)

PRELIMINARY SAMPLING SUMMARY

Sample Source Location/Operation	Type of Sample	Preservation	Analyses to be Conducted
	Floor sweepings	None	Metals, Phenols, and Pesticides
Retan, color, fatliquor	Residues	None	Metals, Phenols, Sulfides, and Pesticides
	Floor sweepings	None	Metals and Phenols
Finishing	Finshing residues	None	Metals, Phenols, Acrylates, Cyanides, and Sulfides
	Buffer dust	None	Metals, Phenols, and Acrylates
	Air pollution filters	None	Metals, Phenols, and Acrylates
	Floor sweepings	None	Metals and Phenols
Other	Screenings	None	Metals, Phenols. Sulfides, and Pesticides
	Treatment plant sludges	None	Metals, Phenols, Sulfides, Cyanides, Pesticides, Acrylates
	Incinerator residue	None	Metals

Source: SCS Engineers

11. Garden trowel or similar small scoop

12. Rubber gloves

13. Knife or scissors

14. Coveralls, lab coat, etc.--optional

Sampling Procedure

1. Mark carefully on a gummed label, affixed to the outside of each sample bottle, the appropriate identifying codes, dates and so forth using a black, waterproof marking pen (see Figure 1).

2. Assign a different sample identifier to each sample taken at each plant. Sample identifiers are numbers beginning with 1 which identify samples and indicate the total number collected at the plant. The first sample taken at a plant will be given sample identifier 1, and so forth. In the case of composited samples, the identifier is associated with the sample container which may contain two or more portions which make up the sample.

2. Utilizing the trowel or pitcher, whichever is appropriate, fill the sample container to approximately 80 percent of total volume. Cap the bottle tightly. Avoid spilling the sample material on the outside of the containers to help minimize odor during sample shipment.

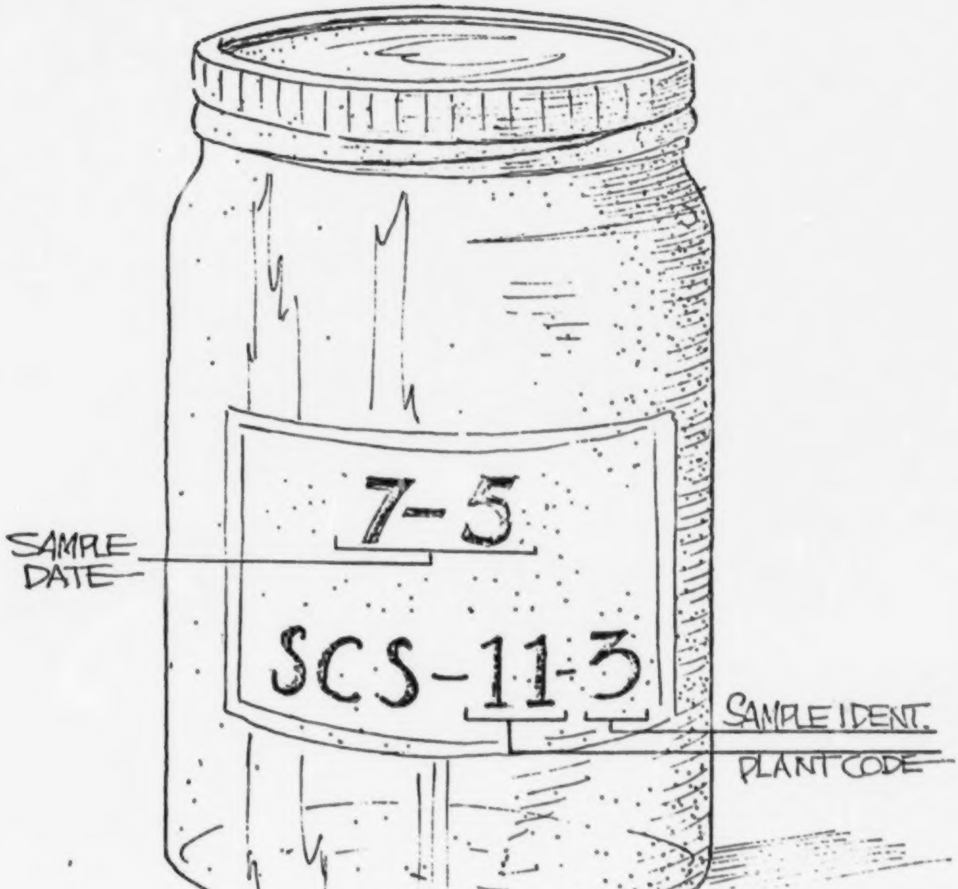
3. Measure pH of sample

4. Complete two copies of Sampling and Analysis Data Form, Exhibit A, and one copy of Sample Inventory Form, Exhibit B.

5. Samples of fleshings or trimmings from fresh hides and samples with a pH less than 12 which are to be analyzed for sulfides should be stored and shipped at 3 to 4 degrees C. All other samples may be stored and shipped at room temperature.

Packing and Shipment of Samples

All samples must be packed in corrugated boxes with adequate padding material to avoid breakage. Plenty of crumpled newspaper or other packing material will be placed below, above, and around each sample bottle. Tops of the bottles should be in the same direction.



7-5
SAMPLE DATE
SCS-11-3
SAMPLE IDENT.
PLANT CODE

SAMPLING CONTAINER LABELING

FIGURE 1

EXHIBIT A

SCS ENGINEERS
LEATHER TANNING AND FINISHING

SAMPLING AND ANALYSIS DATA FORM
(to be sent with each sample)

Plant Code ____________________ Name of Sampler ______________
Sample Identifier ______________ Date Sampled ________________

Type of hide: cattle _______ sheep _________
pig __________ buffalo ________
other ________

Source of hide (be specific): domestic _____________ foreign __________

Type of hide used: 1. fresh ___________ brined ____________
tanned ___________ salted ____________

2. summer ___________ winter ____________

Sample location : ____

Type of sample: (check)
1. Hair - save residue ___________
2. Pulped hair residue ___________
3. Fleshings ___________
4. Trimmings ___________
5. Splits and shavings ___________
6. Tanning sludge ___________
7. Treatment plant sludge ________
8. Buffer dust ____
9. Air pollution control device ______
10. Screenings ______
11. Floor sweepings _
12. Other __________

Refrigerated during shipment (circle one): Yes No Sample pH ____________

Appearance: Color ______________________ Stratification ____________

Other ____

Other remarks: ____

****
(cut here)

Plant Code ________
Sample Identifier ______

Receipt of Sample
(to be completed by laboratory and returned to SCS)

Date received: _______________________ Sample temperature ____________

Condition: Broken container _____________ Odor ____________________
Box open ____________________ Mold ____________________

Appearance: Color _________________________ Stratification ___________

Other ____

Other remarks: ____

Sampling and Analysis Data Form
Page 2

Plant Code ____________
Sample Identifier _____

Laboratory Results
(sampler must indicate analyses to be performed)

Analyses to be Conducted	Parameter	Results (ppm)	
		Wet Basis	Dry Basis
	All Pesticides		
	Aldrin		
	Dieldrin		
	Endrin		
	Heptachlor		
	Heptachlor Epoxide		
	DDT (Mixed Isomers)		
	p,p-DDE		
	p, p-TDE		
	Methoxychlor		
	Chlordane (alpha)		
	Toxaphene		
	Strobane		
	Lindane (gamma BHC)		
	Mirex		
	Hexachlorophene		
	Hexachlorobenzene		
	Dacthal		
	Perthane		
	Polychlorinated Biphenyls		
	All Metals (by AA)		
	Cd		
	Cr		
	As		
	Cu		
	Pb		
	Hg		
	Be		
	Se		
	Zn		
	Zr		
	Phenols		
	Cyanides		
	Sulfides		
	Methyl acrylate		
	Ethyl acrylate		
	Acrylic acid		
	Moisture		
	Emission Spec	Report on Separate Form	
	Other (specify)		

EXHIBIT B

SCS ENGINEERS
LEATHER TANNING AND FINISHING

SAMPLE INVENTORY FORM

Plant Name ______________________________________

Plant Code _____ __ Date(s) Visited _________________

Field Team ______________________________________

Sample Identifier	Type of Sample (describe process and sampling situation)	Remarks

Samples requiring refrigeration should be packed, as described above, in insulated containers. Styrofoam sheets or an inexpensive stryofoam ice chest packed in the corrugated box may be used. Don't forget to put the blue ice in with the refrigerated samples.

Include one copy of the Sampling and Analysis Data Form for each sample shipped.

Tape the sample boxes securely with strapping tape. Affix the mailing label and mark the box "Fragile" and "This Side Up" to keep the bottles upright.

Samples should be shipped prepaid to:

Daylin Laboratories
2800 Jewel Avenue
Los Angeles, California 90058

Shipment of refrigerated samples should be made by air unless plant is within 2 days of Daylin Labs. Refrigerated samples are to be sent such that they will arirve at Daylin Laboratory Monday through Friday-check estimated delivery time.

Other samples should be shipped as soon as possible by surface carrier if the samples will arrive within one week, if not, ship by air. The following carriers are suggested:

- United Parcel Service (UPS)
- REA
- REA Air Express
- Emery Air Freight
- Various airlines' air freight - check if they will deliver

Field personnel should call Mr. Henry Espoy at 213/582-0981 with the following information as soon as possible after sending the samples:

A. Number of samples and boxes shipped
B. Date and time shipped
C. Carrier used
D. Estimated time of delivery

Laboratory Procedures. Samples were packaged and shipped by air freight to Daylin Laboratories, Los Angeles, California, for analysis. Upon receipt at Daylin, the box of samples was immediately unpacked, the bottom portion of the first page of each Sample and Analysis Data Form was filled out by a Daylin technician, cut from the rest of the form, and mailed back to SCS in order to verify receipt of samples. The samples were grouped by code number where possible, and Daylin job tickets were written up for each sample. Master sample sheets were also prepared at this time and distributed to the various departments to notify them of their work on a given sample set.

The samples were first transferred to the main laboratory. At this point, each individual sample was mixed thoroughly to ensure homogeneity. Each individual sample was then divided in sub-samples or portions which were labeled and distributed to the respective analytical departments. At least one sub-sample was frozen as a backup sample. Upon receipt in the individual laboratories, the samples were preserved by refrigeration or by chemical means, where a specific analysis required preservation.

These samples were then subjected to a variety of chemical analyses. The three major types of analytical procedures used were atomic absorption, gas chromotography, and wet chemical methods. The procedures used to prepare the samples and references to the actual analytical procedures are outlined below.

Metal Analysis by Atomic Absorption.

Sample Preparation. The method used to prepare samples for the determination of mercury involved drying all solid samples in a 60°C oven prior to analysis. All liquid samples were held under refrigeration until analyzed.

The method of choice for the preparation of all other metal samples was a wet digestion. A representative portion of the sample is placed in a Griffin Beaker; then 3 ml of concentrated sulfuric acid, and 10 ml of concentrated nitric acid are added to the sample. The acid-sample mixture is then heated on a hot plate until all organic matter is decomposed, and sample solution is effected. After digestion, the sample is cooled, adjusted to a volume of 100 ml and analyzed.

Sample Analysis. All metal analyses were performed using the procedures found in Reference 1 with the exception of zirconium. Appropriate page numbers in Reference 1 are included for each metal.

- Cadmium, pg 101-102
- Chromium, pg 105-106
- Copper, pg 108-109
- Lead, pg 112-113
- Mercury, pg 134-138
- Beryllium, pg 99-100
- Zinc, pg 155-156
- Zirconium, Analytical Method No. 41, Reference 2

Pesticide Residue Analysis by Gas Chromatography. The procedures used for the determination of pesticide residues in the submitted samples are referenced below. Specifically because of the detailed nature of the procedures, only the principles of the methods developed by the Food and Drug Administration are presented below.[3]

Each sample to be analyzed for pesticide residues was subjected to an extraction and cleanup procedure following Sections 212.1 thru 212.17 of the Pesticides Analytical Manual, Volume 1. Where required due to the fat content of the sample, procedures 211.1 thru 211.12a were followed to partition the residues between petroleum ether and acetonitrile.

The samples were initially extracted with acetonitrile by blending at high speed for several minutes. The extraction mixture was then filtered and the filtrate diluted with water in a separatory funnel. Ten ml of saturated sodium chloride solution was also added at this point. The residues are then extracted into petroleum ether.

The concentrated residue obtained from the evaporation of the sample was then subjected to cleanup on a Florisil Column. Where the concentrate appeared to contain an excessive amount of fatty material, the sample was partitioned between acetonitrile and petroleum ether to remove excess fat prior to separation on the Florisil Column. The various residues were then eluted from the Florisil Column with mixed petroleum and ethyl ethers. The recovered materials were concentrated by evaporation, and analyzed by gas chromatography.

Chemical Methods of Analysis.

Sample Preparation. Upon receipt of the individual subsamples, portions of the sample were removed for preservation. When the cyanide, sulfide, or phenol analyses could not be started upon receipt, the samples were preserved using the procedures outlined under the methods chosen.

Sample Analysis. The following procedures, except for selenium, are taken directly from Standard Methods for the Examination of Water and Waste Water, 13th Edition, American Public Health Association, New York, 1971.[4]

- Moisture--procedure 224G, Method for the determination of total residue by evaporation on solid and semi-solid samples.
- Arsenic--procedure 104A, Silver Diethyldithiocarbonate Method for the determination of arsenic.
- Cyanides--procedure 207, Method for the determination of cyanide in wastes.
- Phenols--procedure 222, Sections A,B, and C for the determination of phenols in waste.
- Selenium--Cummins, L. M., J. L. Martin and D.D. Maag. "An Improved Method for Determination of Selenium in Biological Material," Analytical Chemistry, 37, 430-31, 1965.
- Hexivalent chromium--procedure 307B, Diphenylcarbazide cobrimetric method
- Sulfides--procedure 228A, Titrimetric (Iodine) method for the determination of sulfides.

REFERENCES

1. Manual of Methods for Chemical Analysis of Water and Wastes, Environmental Protection Agency, 1974, EPA 625/6-74-003.

2. Atomic Absorption Analytical Methods, Jarrell-Ash Division of Fisher Scientific Co., Waltham, Massachusetts, March 1972.

3. Pesticide Analytical Manual, Volume 1, Methods which Detect Multiple Residues. U.S. Department of Health Education, and Welfare, Food and Drug Administration, revised September 1972.

4. Standard Methods for the Examination of Water and Wastewater, 13th Ed., American Public Health Association, New York, 1971.

Appendix C
Private Disposal Sites
Accepting Tannery Waste

EPA Region	Name, City, State	Type of Tannery Waste Accepted	Remarks
I	Middlesex Disposal Co. Billerica, MA Burt Shaffer (617) 884-3208	Chrome fleshings	
	Charles George Disposal Co. Tyngsborough, MA Charlie George	All	
III	Elam Fox Estate Oley, PA	Buffing dust sludge	Land spreading on agricultural crops
	F. R. & S. Landfill Baumstown, PA Mr. Peiffer	All	
	Christman's Landfill Lenhardtsville, PA Dennis Christman	All	
V	CID Corporation Calumet City, IL Richard Morehouse	All	
	Lake Landfill, Inc. (Browning-Ferris Ind.) Northfield, IL Bill Ketter Carl Hansen (312) 498-0863	All	Certified by IL EPA to accept industrial waste. Leachate is collected & recirculated
	Northeast Gravel Co. Rockford, MI	Buffing dust & dewatered primary sludge	

EPA Region	Name, City, State	Type of Tannery Waste Accepted	Remarks
	Lauer Landfill Washington County, WI	All	State permitted for industrial waste
VII	Wheeling Disposal Service St. Joseph, MO Clay Buntrock (816) 279-0815	Primary sludge	Certified by State to accept tannery waste (clay-lined trenches) & pesticide containers (landfill)
IX	American Canyon Landfill Vallejo, CA	All	

Appendix D

Methodology for Projecting Waste Quantities on a State, EPA Regional, and National Basis

During the conduct of this study, the following methodology was used in order to develop estimates of the quantities of the various types of process solid waste generated by the tanning industry. Visits were conducted to 41 tanneries during which information was obtained on the quantities and the various types of solid waste produced, and on the daily production at each tannery (in units of hides per day). Based on the types, quantities, and composition of the waste produced at the tanneries visited, the tanning industry was divided into seven categories.

In order to arrive at quantities of solid waste produced within each category on a state, EPA Regional, or national basis, solid waste generation factors (kg per unit of production) were calculated for each tannery visited, and the resulting values were averaged for each type of waste generated within each tannery category. For example, based on the visits to 22 complete chrome tanneries, it was determined that the average complete chrome tannery generated 114 (wet)/100 (dry) kg of unfinished leather trim per 1000 equivalent hides processed (see Table 17). Data to permit conversion from "hides processed" to "equivalent hides processed" was provided by the Tanners' Council.

In order to determine the quantity of solid waste currently generated on a state, EPA Regional, or national basis, each waste generation factor (developed as described above) was multiplied by the production (in equivalent hides per year) in each area. The result was expressed in metric tons per year.

Waste quantity data for tanneries within a particular category were reported by state, groups of states, EPA Regions, and groups of EPA Regions in order to insure confidentiality of tannery production data. In all instances, individual state quantities were reported where possible with the exception of situations where EPA Regions would have to be "split," e.g., reporting New York and then including New Jersey with another region.

For example, Table 23 reports the waste generated by sheepskin tanneries in 1974. In EPA Region I, Massachusetts, and in Region III, Pennsylvania, were reported individually because each has more than three sheepskin tanneries. Maine and New Hampshire were grouped together because New Hampshire has only two sheepskin tanneries. Similarly, all (both) states in Region II were grouped together because New Jersey has only one while New York has 13. Regions were grouped together only when absolutely necessary to insure confidentiality, e.g., EPA Regions IV and VI were grouped together because Florida has two sheepskin tanneries and Texas has one.

In some areas of the country, some tannery waste can be sold as a by-product whereas the same waste is land disposed in other areas, e.g., blue trim and shavings are currently sold in the Midwest, and to a lesser degree, along the East Coast. Thus, state and EPA Regional waste generation tables reflect these variations, i.e., they report only the waste requiring land disposal.

Both total process and potentially hazardous waste were calculated using consistent assumptions and approaches. All national totals reflect the sum of individual entries.

In order to predict the quantity of each type of waste which will be generated in 1977 and 1983, estimates were made of the percent change expected for total production for each category of tannery and for the effects of air and water pollution control on the quantities of particular types of waste. Estimates of the percent change anticipated by 1977 and 1983 for each type of waste (based on these three considerations) were then developed as a single factor, which was multiplied by the quantity produced in 1973 in order to estimate the quantity to be produced for 1977 and for 1983. A sample calculation is provided below.

Sample Calculation--Current Annual Solid Waste Generation.

Example: Quantity of unfinished leather trim destined for land disposal in Region IX from complete chrome tanneries.
Generation factor: 114(wet)/100(dry) kg/1000 equivalent hides
Region IX Production: 1,430,000 eq. hides/year
114(wet)/100(dry) x 1,430,000 = 163(wet)/143(dry) metric tons/year
Unfinished leather trim in EPA Region IX:
163 (wet)/143 (dry) metric tons/year (see Table 18).

Sample Calculation--1977 Projection.

Example: Unfinished leather trim from complete chrome tanneries in Region IX
Factors: air pollution control--no effect
water pollution control--no effect
production increase--6.2% (from TCA)
TOTAL EFFECT: +6.2%

Calculation: 163/143 x 1.062 = 173 (wet)/152 (dry)
Result: 173 (wet)/152 (dry) metric tons/year
(see Table 19).

μσ1460